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SCIENCE

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WHAT CAN THE MODERN CHEMIST LEARN FROM THE OLD ALCHEMY?[1]

IT was with very sincere pleasure that I accepted appointment to the non-resident lectureship in chemistry at Cornell for the coming term. I keenly appreciate the honor of the invitation, not only because it gives me opportunity of being a teacher in this famed university, but also, and even more, because of what I can here learn, for it is with us men of science from Europe as it was in the early days with the philosophers of old Greece, a Plato, or a Pythagoras: they journeyed as wise men to Egypt and returned as students of the wisdom of the Egyptian priests.

Indeed, to learn and to work in such an ideal laboratory as the Baker Laboratory of Chemistry is for every chemist, whether old or young, an actual joy. This monumental Temple of Science not only has the best equipment, but a master of the art, the head of the department of chemistry, has furnished it with light and air. A German once has said of the Chemical Laboratory in Munich: "In diesem Hause stinkt es sehr, Dies kommt von Adolf Baeyer her." The Baker Laboratory of Chemistry is exceptional in this regard, it is the most odorless laboratory of the world; it has *no* smell.

The subject which I have chosen for this introductory lecture is, "What can the modern chemist learn from the old alchemy?"

By some this question may be received with astonishment, while others may raise energetic protest. What? We modern chemists, the witnesses and workers of this "Age of Chemistry," can learn something from the old alchemy, full as it was of errors and fantasies! The daily press is constantly announcing the startling results of scientific research: "The riddles of the world are solved!" . . . "The proton has been isolated!" . . . "Atoms have been decomposed!" . . . "The chemical elements have been changed one into another!" . . . "The philosopher's stone has finally been found!" . . . "The transmutation of cheap elements into gold has been accomplished and patented," etc., etc. It almost seems as if we chemists were on the direct road to become God-like and all-powerful, but if we actually were so all-powerful, what would there be left for us to learn, and how could we control the enormous forces which we had developed?

1 Introductory public lecture by Professor Paul Walden, of the University of Rostock, non-resident lecturer in chemistry at Cornell University.

In the days of the old alchemy there flourished in Italy a poet, Augurelli, who presented in 1518, in hexameter, to Pope Leo X, a work upon the "*Chrysopoeia,*" or the true art of making gold. As a reward the pope presented to this possessor of the Philosopher's Stone an empty purse, since to a man who possesses the secret, nothing is lacking except a purse in which to place and keep the artificially prepared metal. The Past and the Present!

Let the past furnish us a warning against too much phantasy in modern chemistry.

Let us examine with the magnifying glass of time the development of chemistry through separate characteristic periods of the past, in an attempt to see more clearly the relationship between the science of to-day and that of the "good old times" which have largely been forgotten. In this glance backward, we will consider first the old chemists as men and as the so-called "Fathers of Chemistry." Second, the methods of work of the old chemists, experiment or sophistry. Third, the problems and the goal of the old chemistry, and fourth, the purification of matter then and to-day—the purity of matter as a fundamental problem of the chemistry of the future.

I. *The Old Chemists as Men, and as the so-called "Fathers of Chemistry"*

Seven cities once claimed to be the birthplace of the renowned Homer. But while place and time of this gifted poet's birth are veiled in obscurity, his name and writings endure. And so is it with the origin and the name of chemistry. Think of the many terms which were applied to the science—Egyptian, Holy, Hermetic Art, Poiesis, Scientia Alchimiae, etc. And yet the name *Chymia* means nothing further than cast metal, and Chymie, the art of casting metals.[2]

Where was the birthplace of this Chymie? Who were its founders? Some ascribe its origin to Egypt, others to India and China, others, more recently, to Babylon and Assyria. A fourth group of historians find the beginnings of the *science* in classic Hellas, while still others give to the Arabians the credit for the *practical* development of chemistry. And thus we see the mythical Hermes Trismegistos hailed as the seer of magic and chemistry, Empedocles as the father of the theory of the elements, Democritus as the originator of the atomic theory, Geber as the father of alchemy. Paracelsus is honored as the father of iatrochemistry and Masson has recently bestowed upon Robert Boyle the comprehensive title, "The Father of Chemistry."[3] Some of you are also acquainted with the judgment of Wurtz[4]—"La chimie est une science française, elle fut constituée par Lavoisier," and toward the end of the nineteenth century Grimaux[5] stated, "Toute la science moderne n'est que le developpement de l'oeuvre de Lavoisier."

We will not seek to decide which of these pioneers is entitled to the greater credit or whether the striking advances in the beginning of our science are due jointly to Boyle with Becher and Glauber, or to Lavoisier with Stahl, or to Priestley, or Scheele, or to Cavendish. Nor can the development of "toute la chimie moderne" be ascribed to a Dalton or an Avogadro, a Davy, a Berzelius or a Faraday. No single man is entitled to be called the "father of chemistry." And to those who seek to give this title to any single man the terse instruction in the Civil Code of Napoleon might be quoted, "La recherche de la paternité est interdite!" Let us not be so narrow-minded as to attempt to proclaim any one single man as the "father of chemistry," but rather let us regard the development of the science as the product of the combined intellects of the men of all times and of a universal search for the truth.

Let us go back to the time of a Paracelsus and the beginning of iatro-chemistry. Chemistry which up to that time had been primarily directed along metallurgical lines underwent decided change in character: *Man* himself, and his diseases, became the chief subject of chemistry. The physician becomes chemist, and accordingly a benefactor of mankind. The knowledge of the iatro-chemist is sought in all countries and at all of the higher institutions of learning, such as Padua, Bologna, Paris and Montpellier, or Leyden, Basle, Prague, Wittenberg and Leipzig. Many incidents in the history of chemistry witness the noblest sort of competition, the highest degree of internationalism and political tolerance, as well as recognition of individual merit. Take the case of the famous French chemist, the demonstrator of chemistry at the *Jardin des Plantes* in Paris, Nicholas Lefebvre, who in 1664 was called to London to take charge of the laboratory of St. James; or that of Wilhelm Homberg (died 1715), successively German lawyer in Magdeburg, medical student in Padua and student of chemistry under Boyle in London, then doctor of medicine at Wittenberg, personal physician to the Duke of Orleans in Paris, finally becoming a noted chemist and a member of the Paris Academy; or Becher, who was successively professor of medicine at Mayence (1666), then director of the laboratory in Munich, member of the Chamber of Commerce in Vienna, in practice at Haarlem and at last in 1680 in England where he examined the Scottish lead mines and smelting works

[2] Diels, "Antike Technik," 2nd ed, 1920, page 124.

[3] Masson, "Three Centuries of Chemistry," London, 1925, page 574.

[4] Wurtz, Histoire des doctrines chimiques, 1868.

[5] Grimaux, Lavoisier, Paris, 1896, page 128.

and in 1681–1682 visited Cornwall and studied the mines and smelting works . . . "here he suggested several improvements and ameliorations." (Thomson, *History of Chemistry,* Vol. I, p. 247, 1830.)

In the olden times a certain privileged freedom prevailed in the practice of the chemical and medico-chemical callings. Knowledge opened the doors to all classes of European culture of that time. This knowledge flowed through the whole world like a liquid. It created a spiritual unity among scholars and paved the way for mutual understanding among the nations and a joint cultural development. Consequently the practical chemist and medical chemist of whatever nation became an international carrier of culture and an apostle of peace.

What about to-day? Must it be so altogether different? If I may be permitted to express my opinion with reference to the creation of the Non-Resident Lectureship here at Cornell, it is this. The value of such an arrangement lies not alone in the scientific and pedagogic activity of the temporary incumbents in their special fields, but further than that, it serves to renew these old and highly ethical forms of reciprocal contacts between scientists in order to create a mutual spiritual atmosphere, and to pave the way for a peaceful cultural development of mankind. From this point of view the step taken by Cornell University may be regarded as historically significant. By this action the great traditions of science become alive again, and we are all moved by the spirit which led Humphry Davy to state publicly one hundred years ago, "Science, like that nature to which it belongs, is neither limited by time nor space; it belongs to the world and is of no country and no age."

II. *The Working Principles of the Old Chemists. Experiment or Sophistry?*

> Thou, youthful seeker after knowledge, investigate and experiment and never desist therefrom, for thou willst harvest fruits a thousand-fold. (Geber)

These were the words of the famous Arabic encyclopedist of the old chemistry, the mythical Geber, some seven hundred years ago. "Labora, Ora et—invenies" . . . did the "adepts" in the monastic cells call out in the middle ages. From among the ranks of the iatro-chemists, we are cautioned at the beginning of the seventeenth century (Crollius, *Basilica Chymica,* 1629), "Alchemy is not attained without work" (that is, experiment).

It is a fact that this uninterrupted work, this indefatigable research has broadened and deepened chemical knowledge. "Desist not therefrom, for thou willst harvest fruits a thousand-fold," so spoke the experienced practician Geber. Are we not struck with awe upon consideration of this old experimental art, which after centuries of endeavor finally succeeded in preparing hydrochloric acid from salt and clay, nitric acid from saltpeter and clay, sulphuric acid from calcined vitriol or alum, and were able with these acids to obtain the key to analysis and synthesis? Think how long these experimental methods took, as compared with the methods of preparation employed in our modern procedure. Only experiment brought the thousand-fold fruits. Very often the latter were not even anticipated by the investigator. They came accidentally. We can, therefore, understand the lesson which Liebig, famous both as a discoverer and experimental artist, gave a hundred years ago. "If one works, one is pretty certain to make discoveries, it makes no difference where one begins."

Any scientific work may lead to a discovery. A pregnant thought. More remarkable, however, are oftentimes the conditions, in particular the mental conditions, under which such a task proceeds. Let us take, for instance, such a divinely gifted discoverer as Sir Humphry Davy (1778–1829). After he had attained world fame, in 1807, by his discovery of alkali electrolysis, it was necessary for him to appear in society more often than he wished. Despite this, he always went to his laboratory after he had returned to his home, where he continued to work until three or four o'clock in the morning. His biography states . . . "His greatest lack was that of time. He was forced to hurry . . . he would put on clean clothes without removing the soiled ones . . . at times he would have on as many as five shirts and several pairs of socks over one another. He would often arouse astonishment among his friends with the speed at which his corpulence increased and decreased" (Paris). One has often said jokingly that Davy's greatest discovery was Faraday. Faraday, a man who was seldom congenial, wrote of his works (1845), "I am so engrossed in discoveries that I have barely time enough to eat."

There is another, in whom literature and science in unique combination led to great results. Goethe, the famous poet, creator of Faust, was also a great natural scientist. After he had discovered the middle jaw bone in man, *Os intermaxillare,* in 1784, he wrote in a letter, "It has become a delightful avocation for me; I have made an important and pretty anatomical discovery, and I am so happy that my internal organs dance."

Here Goethe has succinctly revealed the psychological principles of work and discovery. It is the joy in the progress in the work which raises one to a high emotional pitch, a rare feeling of happiness; his spiritual exaltation stimulates his physical power, and causes the investigator-discoverer to forget all the

usual necessities of the body. This joyful feeling has been experienced by everyone after he has recognized or made certain of a new scientific truth as the result of experiment. It is not the momentary practical value that calls forth the feeling of happiness, but the knowledge that the great Creator and Ruler of the world has revealed to us something which has heretofore been hidden.

One often hears the question: Has this or that scientific observation or discovery any value or use? The history of the development of science and culture has invariably shown that value or use are only relative terms, and are in only partial dependence upon time, place and culture. The answer which the great Benjamin Franklin once gave still holds good to-day. One asked concerning the value of discovery. His answer, as you know, was: "What is the use of a child? It may become a man!"

Thus far I have depicted experiment as the basis for chemical knowledge and advances in chemistry. It is indeed an enlightening fact, perhaps decidedly so at present, to note how in the olden times words of caution were continually expressed condemning the metaphysical and philosophical method in chemistry.

Even Geber about the year 1200 deemed it necessary to advise warningly: "The beginner in science should not despair. If he is looking for knowledge he will find it, however not by the study of books but by investigation of nature" (Geber, *Summa perfectionis,* Chap. 100). Not the study of the works of the Greek and Alexandrian philosophers and pseudo-alchemists, but a direct experimental study of nature itself.

Does it not strike us as somewhat peculiar when in the year 1600 Crollius (*Basilica Chymica*) again differentiates between two types of chemistry and again speaks with words of warning.

"Alchemy is of two kinds, namely, the natural, greatly honored by the children of the art, and, on the other hand, the sophistica or false, greatly despised by these. . . . Consequently, in this subject no one should believe more than that which experience teaches."

Hundreds of years sank away in the sea of eternity. Then did the great Berzelius say at the beginning of the nineteenth century, "chemistry is 99 per cent. manual labor and practice (that is, an art attained by work) and only 1 per cent. theory." Despite this statement, Justus Liebig, then a student, was obliged to listen to a chemical natural philosophy rather than chemistry. About 1840, Liebig criticized this metaphysical era in natural sciences and chemistry by the statement: "The activity and influence of the natural philosophers up to this time was the scourge, the black death of the century," and especially was this true in chemistry. Does not such a statement as that of the natural philosopher, Carus, to the effect that, "the diamond is a pebble which has come to consciousness," sound somewhat strange to our ears? It was the opinion of K. W. G. Kastner (1806) "that iron in combination with hydrogen goes over to carbon," or conversely that "carbon appears as iron upon loss of all hydrogen."

To-day we should regard these chemical definitions as absurd. That these were even acceptable one hundred years ago gives us food for thought, particularly if we examine with a critical eye some of our own modern views. For scientific fads and errors are seen to recur periodically in the development of the science.

The very fact that leading investigators and naturalists had found it necessary to issue warnings from time to time demonstrates the recurrent ascendency of the metaphysical line of thought. We can, therefore, understand why, toward the end of the nineteenth century, Helmholtz recommended to those pursuing the natural sciences "the strict discipline of the inductive method, a faithful adherence to the facts which made the natural sciences great"; why he praised those who were attempting to "remove from the natural sciences all metaphysical frauds and arbitrary hypothesis," and those who were attempting to "make the natural science a more definite and exact expression of the laws governing the facts."

III. *Aims and Tasks of the Old Chemistry*

In medieval times one spoke of chemistry as a "divine" or wonderful *art.* Divine—"because the works of God are of two kinds: The work or course of nature comprises Philosophia; The works and ways of Christ, Theology. In the practice of both of these should all mortals spend their earthly existence." (O. Crollius, *Basilica Chymica,* 1629, p. 71). Paracelsus taught that "Alchemy is the completion of all nature—and that the stomach is the true alchemist," and, that "medicine rested on four pillars, Philosophia, Alchymia, Astronomia and Physica." Without these one could not begin the work of "preparation, separation and true analysis" or "the solution of natural things" (*l.c.,* p. 58). One sees therefore that a great philosophical *Art,* a wide and diversified *knowledge* including all of nature, and a thorough practical *ability* which must be acquired by constant practice, are required.

How and for what purpose shall this divine art be used? Crollius (*l.c.,* p. 247) gives the following answer, "With heartfelt invocation of God and thankful soul this art is to be used for the glory and praise of their Creator, for the benefit of their needy fellowmen, and for the honor of this art, Amen."

We can learn much from this three-century old

characterization of chemistry. The purposes and activities of chemistry were not in those days limited to mere technical knowledge. Chemistry was altogether a study and knowledge of nature; its application was service to mankind, in the name and to the glory of God, as the Creator and guide of nature and of the world. The old chemists were imbued with the idea of a kind of divine service or *idyllic* research, and a feeling of security with God.

I made the remark just now that an idealistic searching imbued the old chemists. Many fundamental writings were credited to the old monk, Basilius Valentinus. Is it not remarkable and characteristic of the sixteenth century and the people living at that time, that this monk never lived, and consequently did not himself write these volumes, but that the actual learned author has hidden his identity under this pseudonym?

Does it not make us modern chemists and narrow specialists somewhat retrospective when these, so often misunderstood and ridiculed chemists, so-called alchemists and iatro-chemists, are depicted as veritable romanticists, idealists and moralists. Should we not glean some teachings for our own spiritual guidance from these far past times? Has it not unfortunately become a fact that in our research we have practically lost all connection with nature: that our chemistry is no longer a "natural science"; that it no longer represents a knowledge of nature as a whole, but that it threatens to resolve itself into a host of individual sciences?

Even to-day, looking back but a few years, we can hardly conceive how Joseph Black (1728–1799) could be at the same time a physician, physicist and a great chemist; or how the romanticist of science, Joseph Priestley (1733–1804) could be a theologian, linguist, physicist and a chemical discoverer *par excellence;* or how Jacob Berzelius (1779–1848), physician, could at the same time be a pioneer in mineralogy and a world leader in chemistry; how he could master the applied, analytical, physiological, inorganic, organic and theoretical branches of chemistry in classical style, and how he could unify chemically dead and living nature in its connections and behavior . . . Is it not true that we have become rich, yes very rich, in details, but poorer in "natural science"? Have we not cause for serious concern over the future development of a chemistry, so productive in individual facts, but so unsatisfactory from the point of view of the great ideas in a world of dead and living matter?

Biochemical Aims of the Old Chemists

"La chymie est imitatrice et rivale de la nature, son objet est presque aussi étendu que celui de la nature même; cette partie de la physique est entre les autres ce que la Poësie est entre les autres genres de littérature." Diderot. (Chemistry is the imitator and rival of nature. Its field is almost as wide as that of nature itself; its relation to physics is as that of poetry to the other forms of literature.)

This proud and frequently quoted passage originated amongst the French encyclopedists at the time when the mechanistic view of life in De la Mettrie's "L'homme machine" and in Holbachs' "Système de la Nature" (1770) found its expression.

However, this goal was recognized as that of chemistry many centuries before! Let me quote from several places in an old book.[6]

In order to imitate natural processes "Time, mass and weight . . . are necessary." The alchemists say that they "reverse the orderly processes of nature with their highly developed art, and that they can revert all matter to the *materia prima.*" They, the goldmakers, boasted still further that they, by their art, excel nature, for not only can they restore to life things which have died, but they can also give life and soul to the inanimate, something which nature had not done either because she was not able or did not wish to do so." (p. 38.) Again they claim that "human beings and other living animals can be created in the laboratory with flesh, bone and senses, and can be given a soul," and that they "can generate trees and plants without their natural seeds" (p. 44), that "burned or carbonized wood as well as metallic ashes, which have gone through the smelting fire, can be made to grow, foliate and bear fruit." (p. 43.) This "divine and supernatural art can create power and riches at will. It restores health to the sickly." Concerning those who have reached the senile age, "it transforms the old man into a youth, stronger and more handsome than he originally was." Finally, those who have almost passed into the beyond can, by its power, again regain the strength to live. The preparation in question is called by the alchemists sometimes "quintessence," again "Philosopher's stone," or "potable gold."

Biringuccio thus portrayed the supreme aim of chemistry or alchemy. At what time was the omnipotence of chemistry so heralded? When did this earlier "Age of Chemistry" exist? In the year 1540! Even then the fundamental premises of chemical work were:—time, mass and weight, as well as reversibility

[6] Biringuccio, *Pirotechnia.* Vannoccio Biringuccio (1480–1538) was a famous builder and metal worker of his time in Rome and Florence. His book "Pirotechnia" is a classical text-book of industrial chemistry. It appeared in Venice in 1540 and recently has been translated by Dr. O. Johannsen, 1925, Braunschweig, Vieweg and Son.

of chemical reactions. How similar are the ideals of the past and our present! The *generatio aequivoca* or spontaneous generation, the palingenesis or the regeneration of the dead matter, the question of Homunculus and the rejuvenation of mankind, etc., are these not problems of our own times?

Truly does not Biringuccio speak concerning these problems of the alchemists when he says, "if the claims were really justified, they should not have given their art the name, alchemy, which it now bears, for they could have said that they have God, the creator of all things, locked in a flask."

May I now be permitted to make an excursion into the field of modern medicinal remedies? You all know the meaning of sunlight therapy. You also know the part played in medicine by mineral salts as foods, and as blood and nerve tonics. You have surely heard of the recent curative methods involving the use of acids (acid therapy) some inorganic, others organic. Diseases of the respiratory system, etc., are cured by them. But even dermatology, neurology, ophthalmology, etc., employ substances of this sort. All of these are important problems of modern medicinal science. But why do I mention these things here? Simply to show that for such cases the old chemists, alchemists and iatro-chemists could well be our teachers, were we to study the past of chemistry more thoroughly. Consider the times three centuries ago. It is a proud maxim which held sway at that time

> "In sale et sole existunt omnia."
> (Life depends on salts and sunshine.)

Oswald Crollius,[7] in Wittenberg, recognized as the most influential disciple of Paracelsus, writes in his book *"Basilica Chymica"* (Frankfurt, 1629):

"Not without cause do the ancients say that everything is contained in the sun and in salts" (*l.c.*, p. 184). From this quotation it naturally follows that special powers were ascribed to those acids obtained from sodium chloride or other salts by distillation with clay. Among these were spiritus salis (hydrochloric acid), spiritus salis nitri (red nitric acid containing oxides of nitrogen). On the basis of the experience of Paracelsus, Crollius (*l.c.*, p. 145) recommends the spiritus salis for about twenty diseases both internal and external. Rudolf Glauber, known as an industrial chemist, greatly extended (1650) the list, requiring some five large pages to enumerate all the diseases for which hydrochloric acid in various doses acted as a curative. That was three centuries ago. To-day we state it in another manner and say that the hydrogen ions are vital. "All living nature is regulated by the hydrogen ion concentration. Health and sickness, life and death, are ruled by it," says Arrhenius ("Chemistry and Modern Life," Leipzig (1922, p. 280)).

The Transmutation of Metals

Even though Geber, in the 12th and 13th centuries, describes and praises the refinement of metals (Liber de investigatione perfectionis), he differentiates between *imperfection* and *perfection*. The way to go from the first to the second is the "praeparatio." He says "Preparation involves the removal of the superfluous, and the addition of whatever is lacking to bring perfection to an imperfect body" (*l.c.*, Chapt. 2). . . . "This can only be accomplished by application of specially adapted methods and the use of purifying agents." . . . "Experience has guided us to various working processes, such as calcination, sublimation, descension, solution, distillation, coagulation and fixation." (*l.c.*, Chapt. III.) The substances which have been found to be useful in this preparative work include "all sorts of salts, alums, vitriols, as well as glass, borax and related substances, very sharp vinegar and fire" (*l.c.*, Chapt. IV). These are the experimental principles of alchemy. Are these not also the principles which have contributed to the origin and development of our present-day chemical knowledge? Are not the old working methods of seven hundred years ago still employed to-day? And is not the purpose of these operations, these preparative methods, namely, that of the purification of materials, scientifically *correct*? Are not both Analysis and Synthesis represented in this ancient methodology? Are we then not heirs, imitators and developers of these past ages?

We have too often ridiculed and misunderstood the alchemists. Justus von Liebig,[8] was right when he said, "Alchemy has never been anything else than chemistry. It has been done a great injustice by confusing it so constantly with the gold-making arts of the 16th and 17th centuries. Alchemy was *a science*, and it included also all branches of the technical-chemical industry."

Besides the old rules for the refinement of metals by purification, which I have just given, the important chapter on the *transformation of metals* is still intact in the old chemistry. Let me point out incidentally that the theoretical or metaphysical basis for the

[7] Oswald Crollius (died 1609) was an outstanding physician (iatro-chemist) who knew what fulminating gold was. He introduced the preparation and the terminology "hornsilver" (luna cornea) for silver chloride, and first prepared tartarus vitriolatus, potassium sulphate, from potassium carbonate and sulphuric acid.

[8] Chemische Briefe, 3rd letter.

"possibility" of such a transmutation is founded in Aristotle's philosophy, namely, in the original substance, *prima materia*. We are, however, primarily interested in another side of this subject "transmutation." Were there any facts which would have led then in olden times to conclude that in chemical operations with the metals lead, copper, mercury, silver and gold, such a transformation had taken place? Or, to put it differently, was it not necessary to assume from certain very definite facts that a complete transformation of most metals into gold had taken place, when one considers the status of the chemical methods for separation and preparation of that time?

Again, did the experienced metallurgists and practical chemists of that day really believe in transmutation? The latter question is truly important, the more so, since it has usually been disregarded altogether in passing judgment on the idea of transmutation.

Let me answer immediately and in the *negative*. The real authorities on metallurgical chemistry gave no credence to the possibility of artificial preparation of gold. Two practical chemists may be quoted as witnesses. One is Biringuccio. In his classical work "Pirotechnia," written at the beginning of the 16th century, he not only disavows all possibility of artificial preparation of gold, but he adds, "I would have to regard people as very clever, a sort of terrestrial angels, were I to believe that they could accomplish this." Even though the other witness, the outstanding practitioner, Rudolf Glauber, defended the transmutation idea, he nevertheless writes: "I will not seek to prove, nor could I do so, that he (Paracelsus) made gold and silver in large quantities. . . . I wish only to indicate that it might be possible to do so. How to do so on a large scale I do not know at present, nor am I particularly interested to know." (*Opera Chymica,* I, p. 369, 1658). From this indirect statement we can plainly see that to him transmutation was regarded as *hypothetically* possible, but that practically he had never actually accomplished it and did not regard it as important. For he says in evident disdain of his theoretical proofs, "nor am I particularly interested to know."

But to return to the other question. Were there any reasons which, to a slight degree at least, made it necessary to assume that a transformation to gold had taken place? This question can be answered in the affirmative. We may regard among such facts the finding of *smaller* or *larger traces* of gold during the course of the ordinary metallurgical processes, a fact which was emphasized again and again. Even the great alchemistical scientist, Albertus Magnus (1193–1280) teaches that gold is found in all minerals. Three hundred years later Biringuccio, whom we have already quoted, writes: "there are few metals which do not contain a trace of gold, some more, some less." Glauber even suggests the *reagents themselves* as a source of gold in chemical processes. He obtained gold as a residue after he had dissolved fine silver in aqua fortis, precipitated it with salt water, washed, melted and reduced it to silver, remelted it and then dissolved it again in aqua fortis. Then he inquires, "Where did this gold come from? From the silver, the aqua fortis, or the salt water, the three substances which were used in the reaction?" It was his belief "that the spiritus nitri had carried over some gold which was present in the iron or copper vitriol used in the distillation." (Glauber, *Opera Chymica, I,* p. 112, 1658.) Is not the negative attitude with reference to the sudden appearance of gold in pure silver a remarkable thing about this argument? What could be more logical than for Glauber to assume that a transmutation had taken place, that is, that gold had come into existence? Glauber regards this question or the "possibility" as so improbable that he does not even mention it, but proceeds in a critical experimental way to examine the reagents used in solution and precipitation to ascertain whether they contained gold. The crude nitric acid, prepared by the distillation of saltpeter and vitriol, he regarded as the probable source of the traces of gold found later in the silver, the particles of gold being carried over from the vitriol during the process of distillation.

Two things can be learned from that which has just been presented, first, that the occurrence of small traces of gold in minerals was recognized many hundreds of years ago, secondly, that the elimination and separation of these minute quantities of gold is accomplished with great difficulty, so that gold that was found in the product of a chemical reaction might be mistakenly thought to have been formed in the process. Glauber's insight must be regarded as truly remarkable, and his statement shows that the clever investigators of long ago knew that the gold was not created in the experiment.

Even if these men, learned in their art and in the knowledge of minerals, did not regard the sudden appearance of traces of gold as transmutation, and did not ascribe its origin to other metals, but traced back its source in classical nineteenth century style to minute quantities present in the reagents or apparatus, the theorists were of an altogether different opinion. Their greatest authority, Aristotle, held that metals were formed from the "original substance" and believed in the growth of metals in the earth and from vapors. The alchemists therefore argued that gold could come into existence during chemical processes. For, they added, did not one actually find it in all metals and minerals?

We must admit that we have come to a critical point in our chemical philosophy. Two opposing views are here met with. As long as we adhere to the conception of an element and regard its stability as a law, the transmutation idea will have no place in chemistry. Conversely, as soon as this conception of an element begins to totter, the idea of transmutation will gain in strength. It has been so in the past and is so to-day. Let me speak briefly concerning the future.

What is our attitude and our scientific belief with regard to the transformation of base metals into gold? How long ago was it when, on the basis of our modern theories, the prophecy was made: "If by some agency or other we could only cause mercury to expel an alpha particle (that is, a positively charged helium atom) and a beta particle (a negative electron), the product would be an isotope of gold" (F. Soddy, 1913). Since then (1913) this statement has been often repeated, unfortunately too often, not only by scientists, but also by the press. As a dogma it has already brought confusion in the minds of the laity, and as a new principle it has served the group of contemporary alchemists and pseudo-chemists to resurrect the old idea of transmutation. Are not statements such as the following often made in popular magazines? "The philosopher's stone has been found"—"The dream of the ancient alchemists has been made a reality by modern science." As you know, this idea has reacted upon modern science, but certainly not to the benefit of modern exact research. The much-disputed question concerning the transmutation of mercury into gold, which Miethe claims to have accomplished, has involved, since 1924, not only a whole group of chemists, both theoretical and experimental, but also business-like speculators. And what has been the result? Unfortunately the witty chemist is right in saying, "the gold of Miethe will probably be found to be the gold of the myth." As before, the old way of making gold (earning money) will be the simpler, less expensive and most dependable.

This suggestion by Soddy gives us a picture of how gold might be formed by the degradation of an element of higher atomic number and greater atomic weight. If mercury, which has an atomic weight of 201, can be robbed of an alpha particle which has a weight of 4, the remaining substance would have a weight of 197 and this is the weight of gold. To-day such a suggestion seems scientific to us. But was not the suggestion of Boerhaave brought forward two hundred years ago just as scientific? Silver in his day was represented by the symbol ☽, a corrosive (an acid) by +, gold by ☉, and mercury by the symbol ☿. An old English statement (Boerhaave, *New Method of Chemistry*, 1727) runs as follows: "Quicksilver evidently shows gold in the middle or body of it, silver at the top or in the face and a corrosive at the bottom, accordingly all adepts say of mercury that it is gold at heart, whence its heaviness, that its outside is silver, whence its color. . . . And hence that maxim upon mercury: Strip me of my clothes, and turn me inside out, and all the secrets of the world will come forth." There is much food for thought in these words. Is it not peculiar that, just as to-day, mercury played the rôle of mother substance for the artificial preparation of gold? Does not this old symbol of transmutation greatly resemble the modern one? There "the heaviness at heart," here the atomic mass at the center; there the visible properties ("white color") on the outside, here the outer electrons. Does not the one say "Strip me of my clothes," while the other says "remove an alpha and a beta particle"? And do not the two symbols resemble each other furthermore in view of the fact that they have remained nothing but symbols in spite of all experimental efforts? The mode of expression of Boerhaave might well here be used. Not the "clothes" but the "whole skin" would have to be removed!

Let us forget for a few minutes our modern views as scientific aids of a given era. Let us regard as analytical chemists, without any theory, the observations during the bombardment of mercury by electrons and the varying traces of gold coming to light during this treatment. Would it not be more logical to assume that mercury, despite all purification, was still contaminated with minute quantities of gold? If the old chemists were able to detect weighable quantities of impurities, such as a grain of gold by purely chemical means, may not the charge of the electrons be the physical aid, assisting in the separation of the last traces of gold in mercury, and the isolation of quantities to the order of 10^{-8} to 10^{-9} grams? It seems to me that the difference between the past and present lies in the order of magnitude of the applied energy and amount of the impurities which have been separated.

That brings us to the problem of the "*purity of our materials.*" It is a peculiar and striking characteristic of the older alchemists that they seemed to show no curiosity concerning many substances which they observed in the course of their experiments, and made no attempts to investigate them. Thus we find that these old chemists had seen and described the oxides of nitrogen more than seven hundred years ago, had used chlorine in their aqua regia, had obtained sulphur dioxide directly by burning sulphur in air, knew of the formation of hydrogen from iron and sulphuric acid and of its explosibility—yet all these things had to be discovered, that is, identified, recognized and differentiated chemically at the end of the eighteenth century!

IV. *The Problem of "Pure Substances"*

A Berlin physicist, Peter Riess (died in 1883), known for his work in frictional electricity, defines chemistry as the "impure part of physics." Let us assume that such was the relationship between chemistry and physics 75 years ago. The question naturally follows whether the methods or the materials could correctly have been labelled "impure." If we frankly investigate this question, we will find that his charge is justified. Indeed, the problems of purity and methods of purification are of fundamental importance to both pure and applied chemistry. The gradual progressive expansion of qualitative reactions and methods of separation of the individual metallic and gaseous substances did not reach its development until the eighteenth century. Particularly well worked out were the wet analytical methods which soon caused the enrichment of chemistry by 15 new elements. Further differentiation of substances which had heretofore been regarded as homogeneous, by electrochemical and spectroscopic methods in the nineteenth century, is generally known. It is probably not known how many countless substances, now recognized as elemental by every beginner, were regarded as compounds, or how substances later proven to be compounds were considered to be elements. Take the case of uranium, and its oxide, which for fifty years was thought to be the element, or that of titanium nitride, TiN, which was thought to be the free metal.

According to Davy the diamond contained oxygen; phosphorus and sulphur were compounds containing these elements together with oxygen and hydrogen. Berzelius defended the opinion that chlorine contained an element "murium." Nitrogen was a compound according to Davy, and even as late as 1825 Berzelius contended that nitrogen was the suboxide of an element "nitricum." The metals potassium and sodium discovered by Davy were considered by Gay-Lussac and Thenard as compounds of the metal with hydrogen (1808).

If we inquire as to the causes of these erroneous conceptions, the answer is not difficult to find: the undeveloped state of the methods for separation and purification; in other words, the presence of impurities.

If we survey the present, and examine carefully the modern views concerning the nature of the various elements, we will find much in common between the newer and older ideas. The compound nature of the elements was even then a subject for speculation and one which had been repeatedly tested by experiment. The old idea of hydrogen, as a component of all matter, is again accepted in the form of the proton.

Many of our other most modern conceptions find their predecessors in the past. We have already mentioned the fact that Berzelius regarded nitrogen as a compound substance and defended his views very skillfully. That it should be nitrogen, which after just one hundred years should have partially been broken down by Rutherford by bombardment with alpha rays, is a unique phenomenon in the progressive development of our views.

According to Einstein's theory of relativity, a transformation of mass into energy is possible. It has often been said that such a change, as in the case of one atom of nitrogen, would be accompanied by the evolution of an immense quantity of heat which could become economically valuable. According to the well-known Einstein equation, $E = mc^2$ (where E = energy, m = mass, c = speed of light), a quantity of heat equivalent to that obtained by the combustion of 3,000 tons of coal would be obtained by the destruction of one gram of any substance.

More than one hundred years ago Lichtenberg, professor of physics at the University of Göttingen, made the following statement: "If one could only invent some suitable substance to decompose the nitrogen of the air in order to set free its heat, it would be one of the greatest discoveries of economic importance." The reversal of the Einstein equation permits the transformation of energy into mass ($m = E/c^2$). The modern successors of the old alchemists, the hyperchemists and Theosophists, could well maintain from their point of view that this transformation or materialization of energy has long been known to them. It is reported in all earnestness that in the year 1666, at The Hague, in presence of the physician Helvetius, gold made artificially from lead actually gained in weight. Another report concerning an incident in Vienna (1716) states that in the transmutation of copper pennies to silver, there was obtained 125 pounds of silver from 100 pounds of copper.

Concerning the question of the transformation of energy back into matter we can also quote Glauber from his treatise on "*De Auro Potabili.*"[9] "It is believable that if we knew a suitable container, we could catch and coagulate in it the rays of the sun as well as the heat from ordinary fire, and thus metals could just as easily be generated on the earth as in the earth." But let us return to our consideration of the historical rôle played in chemistry by "traces" or "impurities." A special volume might be written concerning this influence in the development of chemistry. Think of the part played by catalysts in chemical industry. Consider the vitamins and the most recent experiments of Windaus in physiological chemistry. We will limit ourselves to a few such examples.

Material perception and abstract classification fol-

[9] *Opera Chymica*, II, 328, 1659.

low each other only after long periods of time. Besides the kind of matter the quantity of matter is important in the history of this development. With advanced analytical-chemical procedure, the smallest traces such as accidental, subordinate and minute quantities of a foreign body become sources for the discovery of new elements. Modern industry has learned to value and accumulate these "traces," and to transform them into appreciable quantities. Take the case of tungsten, titanium, selenium, thorium, uranium, radium, helium, germanium, etc. At the same time, this change in practical value of what were once impurities has served to develop the method and sensitivity of their detection and recognition. Thus gold can now be detected in quantities as small as $10^{-8}-10^{-9}$ grams; helium in amounts as small as 10^{-9} cc (Paneth, 1926); one part of mercury in 1½ million parts of coal tar (Kirby, 1927) and iodine in amounts as minute as 10^{-6} grams can be discovered if present in the soil, plants, meteorites and iron ore, yes, even in steel itself (Fellenberg and Lunde, 1927).

We become contemplative when we find, on the other hand, that even in our purest preparations, using the utmost precautions, such "traces" are still detectable. Let us recall the gold from mercury (Miethe) and the formation of helium from tungsten (Wendt and Irion, 1922). Let us not forget the discovery that quartz vessels hold gases very tenaciously, even after heating for many hours above 1000° C. and being thoroughly exhausted with a pump (W. Biltz and H. Müller, 1927). You all know of the remarkable observations of F. Paneth and his coworkers in 1926–1927, which seemed to indicate the transmutation of hydrogen into helium, with the aid of finely divided palladium. More thorough investigation showed, however, that the asbestos which was used in the apparatus contained helium. Countless other examples could be cited.

We thus see how experimental difficulties which are barely surmountable confront us in the case of such simple and stable substances as the elements. The term "purity" can be applied only to an ideal state, in that this condition is approached asymptotically with our experimental technique as it is at present. What then are we to expect in regard to the purity of compounds, organic and inorganic substances of highly complex nature and by no means stable? How simple—*sit venia verbo*—rather how primitive, are still our customary qualitative tests for purity in this field! One could almost say that we of to-day are scarcely further advanced in the testing of the purity or individuality of complicated compounds than were the old chemists in the testing of the purity of metals. However, the problem of pure, or we may say "ultra-pure" substances has yet other important phases.

As long as we are satisfied to be able to detect the presence of these previously mentioned "traces" of foreign substances in our purest materials, we stand on the firm ground of experimental analytical chemistry. Berzelius held that chemistry consisted of 99 per cent. experiment and one per cent. theory. And we have reason to be proud of being able to detect such a small amount of a gas as 10^{-9} cc, which, in simple illustration, would mean that if this laboratory were a single large box full of air, and we liberated a thimbleful of a rare gas in the building and mixed it thoroughly with the air, we could then detect that gas in a sample of air taken anywhere in the building. But in some cases our modern methods of reasoning suggest an "explanation" for the presence of these minute quantities of matter: we say that they have come into existence by transelementation. Is it not peculiar and psychologically interesting that we, with all our logic and weighty experience, should capitulate so quickly to this new idea? In what other branch of chemistry would we so readily accept so radical a theory? Have we not returned to the reasoning and evidence of the alchemists and those who believed in transmutation, and who believed in transmutation because they wished it?

We are witnesses to-day of a tendency in research against which warnings were once issued. It was Crollius (1629) who three centuries ago pointed out the danger of the *"Sophistica"* or false chemical art. Helmholtz earnestly recommended thirty years ago a cleansing of the natural sciences of all metaphysical, fraudulent deductions. The scientific study of minutest quantities is actually just as characteristic of the present day as is our development of large scale processes in the industries. If we consider the lessons of the past, and take as our guide the natural causes for the occurrence of these minute quantities, are we not justified in asking this question:—Has the so-called destruction of the atom into unweighable quantities of protons and traces of helium, with total exclusion of impurities from the materials and the apparatus, been realized and can it be realized?

In addition to these metaphysical deductions and theoretical conclusions, whose greatest importance is inversely proportional to the smallest traces, there are other questions for the experimental chemist. For example—What are the chemical properties of the "ultra-pure" elements and compounds? In what physical state and in what chemical combination do traces of substances exist, such as gold in mercury, iodine in steel, gas on the surface of quartz, etc? So we pass from the past with its teachings to the future when we say—In addition to our present chemistry a

future chemistry or "ultra-pure" substances must arise: not only the physical condition but also the reactions of these "ultra-pure" substances must be investigated. How do these substances react on one another and also in great dilution when present only in traces? Is it not peculiar that matter in the "ultra-pure" state behaves very much like the so-called "unsaturated compounds" as is shown in the behavior of ultra-pure water, the Baker extremely dry bodies, etc.?

And this brings us to the end of our discussion. Can we and should we learn something from the old chemistry, from its masters, its methodology and its aims? I think the answer is "Yes." An individualistic rhythm controls the development of chemistry. People and times change, yet certain ideas and ideals persist forever. True enough they undergo a change in form and value with the course of time, but they live on from generation to generation and act as guides for chemical reasoning and research.

Pascal's words will ever remain true:—"La suite des hommes pendant le cours de tant des siècles doit être considéré comme un même homme qui subsiste toujours et qui apprend continuellement." (The succession of men during the course of many centuries should be considered as one and the same man who exists always and learns continuously.)

PAUL WALDEN

CORNELL UNIVERSITY

SARAH FRANCES WHITING

AFTER a life characterized by devotion to high ideals and filled with unusual activities, Sarah Frances Whiting, professor emeritus of physics and astronomy at Wellesley College, died on September 12, 1927, at her home in Wilbraham, Massachusetts. She retired in 1916 after forty years of service at Wellesley.

She was born at Wyoming, New York, in 1846. Through her paternal grandmother she was a direct descendant in the ninth generation from Elder Brewster of the *Mayflower*. Her father, the principal of a series of academies which preceded the New York public schools, was not only an excellent classical scholar, but was also well versed in the science of his day. After graduating from Ingham University in Le Roy, New York, Miss Whiting was a teacher there and in Brooklyn for about ten years.

In 1875, when Wellesley College opened its doors to students, Edward C. Pickering, then professor of physics at the Massachusetts Institute of Technology, had established the first students' physical laboratory in America. Mr. Durant, the brilliant founder of Wellesley College, ever alert for new methods of teaching, was greatly attracted by the reports of the students' experiments. He conceived the idea of duplicating the method at his college, but was seriously handicapped because his faculty was to be composed entirely of women. No woman trained in physical experiments could be found, and in no college was such training offered.

Mr. Durant then inquired of Professor Pickering whether it would be possible for him to allow such an appointee to sit as a guest in his classes, since women were not then admitted as regular students. With his wonted courtesy, Professor Pickering agreed and offered to assist in any way towards establishing such a department at Wellesley.

Mr. Durant's quest for the holder of his chair of physics ended when he found Miss Whiting at the Brooklyn Heights Seminary, where, although teaching mathematics and the classics, she had already become fascinated, as she said, with physics and the revelations of the spectroscope.

She went to Wellesley in 1876 to plan and equip the new department of physics. Four times a week in that busy year she sat as a guest in Professor Pickering's classes, and learned from him of his "physical manipulation." Not only did she have to acquire facility in using the instruments, but it rested with her to decide upon those to be purchased for Wellesley, a perplexing problem in those days when all such instruments were made abroad by firms who did not issue catalogues.

She was therefore obliged to visit the physical laboratories of various colleges and institutes, such as Harvard, Yale, Amherst, Bowdoin, Pennsylvania, and see the instruments before ordering. She was always courteously received, although in those early days when the whole idea of a woman's college was so new, there must have been among the staid professors many a "doubting Thomas" who pondered over the question later asked of her by Sir William Crookes in England, "If all the ladies should know so much about spectroscopes, who would attend to the buttons and the breakfasts?"

Her work was varied and onerous during these early years—deciding upon the instruments and putting them together when they came from Germany carefully packed in many detached pieces; lecturing before large classes, for physics was required of all candidates for a degree until 1893; demonstrating and making the experiments go off successfully without assistants until 1885.

But the very novelty of the whole undertaking was most exhilarating. Something was continually being done for the first time.

In the early eighties, Wellesley's good friend, Professor Horsford, of Harvard, offered to install incandescent electric lights in the college library. Alarm was felt among the trustees lest such lights might be

injurious to the students' eyes. Miss Whiting had already visited the Edison works in New York, and realized how different the incandescent lights were from the glaring, flickering arc lamps then in some public use, and how much better than the lights from the smoky gas manufactured by the college. She therefore obtained some Edison bulbs and offered an exhibition, for which she had to do all the work of preparation, such as setting up a battery of forty nitric cells.

An especially exciting moment came when the Boston morning papers reported the discovery of the Röntgen or X-rays in 1895. The advanced students in physics of those days will always remember the zeal with which Miss Whiting immediately set up an old Crookes' tube and the delight when she actually obtained some of the very first photographs taken in this country of coins within a purse and bones within the flesh.

Her rather frequent visits to Europe always served for widening her knowledge and enlarging her acquaintance with scientific people. As early as 1888, she was received at famous physical laboratories in England, including those of Sir Norman Lockyer, Thompson and Ramsay, Sir Oliver Lodge, Lord Kelvin and Lord Rayleigh. In 1896, there were more opportunities for women and she studied under Tate in Edinburgh. In 1913 she attended the meeting of the International Solar Union in Bonn, Germany.

Miss Whiting's pioneer work in establishing the first experimental physical laboratory in a woman's college did not exhaust her resources, for she also became the founder of the astronomical department of Wellesley College. As early as 1879, she offered a semester of lectures in astronomy. By that time Professor Pickering had become the director of the Harvard College Observatory, and he invited her there to learn of the recent development of the new astronomy along physical lines.

A celestial globe and a portable four-inch Browning telescope comprised Wellesley's total astronomical equipment for twenty years. Meanwhile Miss Whiting was thinking and dreaming of a real working observatory where the telescope and the spectroscope together would tell the whole celestial story to the coming Wellesley girls. At last, in 1898, her dream found a lodging in the brain of one of the trustees, Mrs. John C. Whitin, of Whitinsville, Massachusetts. Mrs. Whitin had always been interested, as she said, in "Other Worlds than Ours," and entered into the plan with girlish enthusiasm, so that within a couple of years a beautiful observatory, of white marble with copper roof, had arisen on one of Wellesley's hills. Once more, Miss Whiting's executive ability was called into action in locating, planning and equipping the new observatory. The main telescope is a Clark 12-inch equatorial. There is also a 6-inch Clark telescope, mounted equatorially, a Bamberg broken transit, with 3-inch telescope, a Browning spectroscope, a Rowland concave grating spectroscope, and two Howard sidereal clocks, besides numerous smaller instruments and very complete apparatus for students' work.

She retired from the department of physics in 1912 and devoted herself solely to astronomy, to which she also applied the laboratory method, attributing to Professor Pickering's inspiration her novel introduction of day-time observing. In her little book "Day-time and Evening Exercises in Astronomy," the result of years of teaching large classes, she includes together with "Study of the Telescope" and "Use of Sidereal Clock" such exercises as classifying spectra and finding the light curves of variable stars from Harvard photographs.

She trained many young women for important positions and always followed their lives with the keenest interest, desiring that their work should not only be scholarly, but that they should inspire their pupils with high ideals and prove in every way that the higher education of women was not a failure.

She was a member of the American Association and the American Astronomical and Physical Societies. In 1905 the honorary degree of Sc.D. was conferred on her by Tufts College in recognition of her pioneer work in physics and astronomy.

Her many years of devotion to science did not by any means deaden the social or womanly side of Miss Whiting's character. She was for years the hostess in College Hall, while many friends and alumnae will always recall with pleasure the delightful hospitality extended by Miss Whiting and her sister at the beautiful Whitin Observatory House.

She had a genius for friendship. The observatory is a memorial to her long years of friendship with its donor, Mrs. Whitin. While in London in 1896, she was a frequent visitor at Tulse Hill Observatory and formed a lasting friendship with Lady Huggins, the gifted colaborer with Sir William in laying the foundations of astrophysics. Because of this friendship Lady Huggins bequeathed to Wellesley College a rare collection of treasures including seven hundred books, fifty pictures, old jewelry and embroideries, and twelve small astronomical instruments.

Always dignified, calm and well-poised, rejoicing in the remarkable development of her chosen sciences and of her beloved college, cheered by life-long friendship with kindred spirits, sustained in every crisis by an unfailing Christian faith, Miss Whiting has left behind her the record not only of an eminently successful, but also of a singularly happy life.

ANNIE J. CANNON
HARVARD COLLEGE OBSERVATORY

SCIENTIFIC EVENTS

THE NEW ENGLAND INTERCOLLEGIATE GEOLOGICAL EXCURSION

THE twenty-third annual excursion of the geologists of New England was held on October 14 and 15 at Worcester, Massachusetts. Dean Homer P. Little, of Clark University, and Professor C. E. Gordon, of the Massachusetts Agricultural College, acted as guides, and the veteran geologist of Worcester, Joseph H. Perry, was an honored guest. Other guests of note were Dr. N. G. Horner, of the University of Upsala, and Professor L. W. Collet, of the University of Geneva. On Friday afternoon the Tertiary course of the "Auburn River" was studied and the Pleistocene changes of drainage were discussed. The granitic intrusions at the Ballard Quarry, southeast of Worcester, offered the party an interesting study in contact metamorphism. At Purgatory, in the town of Sutton, a curious valley has been explained by the late W. O. Crosby and his son, I. J. Crosby, as a graben or "keystone" fault. The evidence in favor of this theory was shown.

On Saturday the party visited the Worcester "coal" or graphite mine and studied the relations of these rocks which contain Carboniferous fossils to the surrounding Oakdale quartzite. The variation of the amount of folding in the two formations led some to doubt the correlations which have been made within the Worcester basin. Lunch was eaten beside glacial lake Nashua, the present Wachuset reservoir of the Metropolitan Water District.

During the afternoon George Hill, in the town of Lancaster, was visited and most of the party carried away specimens of the famous Lancaster andalusites. Those interested in glacial geology found the delta plains about Lancaster and Clinton excellent examples of the effects of Pleistocene glaciation. Later in the afternoon the Worcester phyllite and other of the metamorphic rocks of the Worcester basin were studied in the town of Boylston.

Nineteen institutions were represented at the excursion. The list includes Amherst Agricultural College (1), Brown (8), Clark (4), Colby (3), Hartford (Conn.) High (2), Harvard (12), Massachusetts Institute of Technology (3), Middlebury (1), Mount Holyoke (4), Smith (4), Springfield (Mass.) High (2), Union (1), University of Geneva (1), University of Upsala (1), University of Vermont (1), Wesleyan (3), Williams (1), Worcester (Mass.) High (1) and Yale (4). A number of others interested in geology were present and brought the total attendance to sixty-five or more.

W. G. FOYE,
Secretary

LECTURES AT THE NEW YORK ACADEMY OF MEDICINE

THE following is a preliminary announcement of stated meetings of the New York Academy of Medicine for the season of 1927–1928:

October 20—Carpenter Lecture—*The Present and Future Food Supply of the United States:* ALONZO TAYLOR, director of food research, Stanford University.

November 3—*Recent Knowledge of Epidemic Diseases:* LESLIE T. WEBSTER, Rockefeller Institute for Medical Research, New York.

November 17—Anniversary Discourse: JOHN DEWEY, New York.

December 1—*Malaria in Syphilis:* GEORGE H. KIRBY, director Psychiatric Institute, New York State Hospitals; CHARLES W. STONE, associate professor of nervous diseases, Western Reserve University, Cleveland.

December 15—*Experimental Work on the Tumor Question:* JAMES B. MURPHY, Rockefeller Institute for Medical Research.

January 5—Annual Meeting. *On the Significance of Bacterial Allergy in Infectious Diseases:* HANS ZINSSER, professor of bacteriology and immunology, Harvard University.

January 19—*Graduate Medical Education:* LOUIS B. WILSON, director Mayo Foundation, Rochester, Minnesota.

February 2—*Alcoholism:* MATTIAS NICOLL, JR., commissioner of health, State of New York; CHARLES NORRIS, chief medical examiner, City of New York; ALEXANDER O. GETTLER, assistant medical examiner, City of New York.

February 16—*Animal Diseases in Man:* THEOBALD SMITH, director, department of animal pathology, Rockefeller Institute, Princeton.

March 1—*The Eye in Relation to Disease:* G. E. DESCHWEINITZ, Philadelphia.

March 19—*Physical Therapy:* FRANK B. GRANGER, Boston.

April 5—*Management of the Psychoneuroses:* AUSTIN RIGGS, Stockbridge, Massachusetts.

April 19—*The Future of Surgery:* WALTON MARTIN, New York.

May 5—*Behaviorism and Delinquency:* WILLIAM HEALY, director Judge Baker Foundation, Boston; JOHN B. WATSON, New York.

May 17—*Recent Biological Studies and their Significance:* EDMUND V. COWDRY, Rockefeller Institute for Medical Research, New York.

AWARD OF JOHN FRITZ MEDAL FOR 1928

As previously recorded in SCIENCE, the John Fritz gold medal for 1928 was awarded to General John J. Carty, of New York, on October 21, for achievement in telephone engineering. This annual award was made unanimously by the board of sixteen representatives of the American societies of Civil, Mining and Metallurgical, Mechanical and Electrical Engineers, having an aggregate membership of 57,000.

This medal is awarded not oftener than once a year for notable scientific or industrial achievement, without restriction on account of nationality or sex. It is a memorial to John Fritz, late of Bethlehem, Pennsylvania, long a leader in the American iron and steel industry.

This is the twenty-fourth award; the first was to John Fritz in 1902 in celebration of his eightieth birthday. A few of the other medalists are Elmer Ambrose Sperry, for development of the gyroscope; Edward Dean Adams, for achievement in development of hydroelectric power at Niagara Falls; John F. Stevens, for achievement in planning and organizing for the construction of the Panama Canal, building of railroads and administration of the Chinese Eastern and Siberian Railway during and immediately after the World War; Ambrose Swasey, as a designer and manufacturer of instruments and machines of precision, a builder of great telescopes and the founder of Engineering Foundation; Senator Guglielmo Marconi, for invention of wireless telephony.

The members of the board which awarded the medal for 1928 were:

Charles F. Loweth, chief engineer, C. M. & St. P. Railway.
C. E. Grunsky, consulting engineer, San Francisco.
Robert Ridgway, chief engineer, Board of Transportation, New York City.
Geo. S. Davison, president, Gulf Refining Co., Pittsburgh.
Arthur S. Dwight, president, Dwight & Lloyd Companies, New York.
William Kelly, mining engineer, Iron Mountain, Michigan.
J. V. W. Reynders, consulting engineer, New York.
Samuel A. Taylor, consulting engineer, Pittsburgh.
Fred R. Low, editor *Power*, New York.
W. F. Durand, professor of mechanical engineering, Stanford University.
Dexter S. Kimball, dean, College of Engineering, Cornell University.
Charles M. Schwab, chairman, Bethlehem Steel Corporation.
Gano Dunn, president, J. G. White Engineering Corporation, New York.
Farley Osgood, consulting engineer, New York.
Michael I. Pupin, professor of electro-mechanics, Columbia University.
C. C. Chesney, manager and chief engineer, General Electric Company, Pittsfield, Mass.

The presentation of the medal will take place in February, 1928, in connection with the annual meetings of the American Institute of Electrical Engineers, in the Engineering Auditorium, 29 West 39th Street, New York. The medal will be presented to General Carty by Robert Ridgway, chairman of the board which made the award.

FRED R. LOW, *Secretary,*
The John Fritz Medal Board of Award

THE NEW YORK HOSPITAL–CORNELL MEDICAL COLLEGE ASSOCIATION

OFFICIAL announcement is this week made to the effect that New York Hospital, at 8 West Sixteenth Street, and Cornell University Medical College, First Avenue and Twenty-eighth Street, will be united as a single medical institution. It will occupy a new building, costing with the ground $15,150,000, overlooking the East River between Sixty-eighth and Seventieth Streets, Avenue A and Exterior Street, immediately north of the Rockefeller Institute for Medical Research. Construction of the new building will be started in July, 1928, and it will be completed in July, 1930.

The announcement says:

The faculty and staff will be organized on a university basis, in accordance with the highest scientific standards. The laboratory staff of the Cornell Medical College has long been a full-time staff. In the new unified institution, the important clinical departments will be similarly manned by groups of teachers and investigators who will devote their entire time, and by other groups who give part of their time, to the work of the institution.

The new institution will be operated under the supervision of a joint administrative board consisting of Edward W. Sheldon, president of the hospital; William Woodward and Frank L. Polk, representing the hospital, with President Livingston Farrand, of Cornell University, J. Du Pratt White, a trustee of Cornell, and Dr. Walter L. Niles, dean of the medical faculty, representing the university.

Dr. George Canby Robinson, at present dean of the Medical School of Vanderbilt University, Nashville, Tenn., will be director of the new association, acting as executive officer of the medical faculty and coordinating the work of the medical school and the activities of the hospital.

The new hospital will contain about 415 public beds, seventy-five private beds and an extensive out-patient department—thus approximately doubling the present capacity of New York Hospital.

Messrs. Coolidge, Shepley, Bulfinch and Abbott, of Boston, who have acted as architects for several of the more recent hospital-medical college developments, including that at Vanderbilt University, are preparing plans for the new buildings.

The construction of the main building, to house jointly the two institutions, will be undertaken by the hospital under the direction of Marc Eidlitz and Son, Inc., as contractors, at an estimated cost of about $11,000,000.

Toward carrying out the foregoing plan, the General Education Board has authorized an appropriation of $7,500,000. This appropriation, together with the large legacies to both the hospital and the university provided for in the will of the late Payne Whitney, who died last May, has induced the two institutions to proceed immediately with the work of construction.

The combined financial position and requirements when this enterprise is completed are estimated as follows:

Cost of land, new building and equipment	$15,150,000	
New York Hospital present endowment	15,000,000	
Other hospital buildings and equipment of the New York Hospital, assessed value	5,700,000	
Cornell Medical College, present and promised endowment	9,800,000	
		$45,650,000
ADDITIONAL FUNDS REQUIRED		
New York Hospital, for additional endowment and other buildings	$10,000,000	
Cornell Medical College, for additional endowment	5,000,000	
		15,000,000
		$60,650,000

SCIENTIFIC NOTES AND NEWS

ACCORDING to a cable to the New York *Times,* Dr. Julius Wagner-Jauregg, professor of neuropathology at the University of Vienna, has been awarded the Nobel prize in medicine for 1927, for his discovery of the malaria treatment for paresis. The Nobel prize in medicine for 1926 is said to have been awarded to Professor Johannes Fibiger, professor of pathological anatomy at Copenhagen.

THE Academy of Natural Sciences of Philadelphia presented on November 1 the John Scott medal and $1,000 to each of the following: Dr. Afranio de Amaral, director of the Antivenin Institute of America, will receive the prize for the preparation of antivenins. Dr. Alfred Fabian Hess, clinical professor of pediatrics at the University and Bellevue Medical School and Hospital, will be honored for his discovery of the method of producing a vitamin factor in food by the use of ultra-violet rays. A prize will go to Dr. Peyton Rous, of the Rockefeller Institute for Medical Research, for separating from tumor cells of fowls a substance which produces the disease. The John Scott medal was established by a bequest to the city of Philadelphia in the will of John Scott, a chemist of Edinburgh, Scotland, who died in 1816.

THE unveiling of an oil portrait of Dr. Frank Billings, emeritus professor of medicine in the University of Chicago, took place in connection with the dedication of the new medical school buildings. Hanging over the fireplace in the Billings reading room of the university clinics, the portrait was unveiled at a dinner in honor of Dr. Billings.

DR. ELLIOTT C. CUTLER, professor of surgery at the Western Reserve Medical School, has been elected a corresponding member of the Royal Academy of Medicine, Rome.

THE Cross of a Chevalier of the Legion of Honor of France has been awarded to Dr. Chevalier Jackson, professor of bronchoscopy and esophagoscopy at the Jefferson Medical College, for his "distinguished contribution to science of medicine." The presentation was made on behalf of the French government at a private dinner by Dr. J. M. Le Mee, laryngologist of the Paris hospitals and of the American Hospital in Paris.

THE British Iron and Steel Institute recently awarded the Carnegie gold medal for the year 1925 to A. L. Curtis, Westmoor Laboratory, Chatteris, in recognition of his research work on steel moulding sand.

CHARLES A. LINDBERGH will receive the Hubbard gold medal of the National Geographic Society from the hands of President Coolidge at the Washington auditorium on November 14.

DR. L. O. HOWARD calls the attention of the editor of SCIENCE to the fact that, on page 391 of SCIENCE for October 28, he is made to appear as "the only American honorary member of the Academy of Agriculture of France." He states that the word "honorary" should have been omitted, since this French Academy has no honorary members. He is, however, the only American member.

AT the annual meeting of the American Academy of Arts and Sciences the following officers were elected: *President,* Edwin B. Wilson; *vice-president for class I,* Arthur E. Kennelly; *vice-president for class II,* George H. Parker; *vice-president for class III,* George L. Kittredge; *corresponding secretary,* Robert P. Bigelow; *recording secretary,* Charles B. Gulick; *treasurer,* Ingersoll Bowditch; *librarian,* Harry M. Goodwin; *editor,* William S. Franklin.

OFFICERS of Delta Omega, the national honorary public health society, were elected on October 19, 1927, as follows: *President,* Dr. C.-E. A. Winslow, of the Yale School of Medicine; *vice-president,* Major Edgar E. Hume; *secretary-treasurer,* Dr. James A. Tobey, of New York. Chapters of the society are now established at the Johns Hopkins School of Hygiene and Public Health, the Harvard School of Public Health, the Massachusetts Institute of Technology, the Yale School of Medicine, the University of Michigan and the University of California.

DR. AUGUSTUS TROWBRIDGE, professor of physics in Princeton University, has been appointed dean of the Princeton graduate school in succession to Dean An-

drew Fleming West, who has retired. For the last three years Dr. Trowbridge has been on leave in order to act as adviser to the International Education Board in the appropriation of money for the development of scientific research in European laboratories.

DR. DEAN LEWIS, professor of surgery at the Johns Hopkins Medical School, has been appointed a member of the medical council of the U. S. Veterans' Bureau.

J. E. MORRISON, secretary of the San Diego, California, Chamber of Mines, has been appointed honorary curator of minerals at the Natural History Museum, San Diego.

DR. FLOYD DEEDS has resigned from the position of assistant professor of pharmacology, at Stanford University, to take the position of pharmacologist at the U. S. Hygienic Laboratory, Washington, D. C.

DR. GUY W. CLARK, formerly assistant professor of pharmacology in the University of California Medical School, at Berkeley, has resigned to become director of the pharmaceutic department of the Lederle Antitoxin Laboratories.

DR. HAROLD E. JONES, assistant professor of psychology at Columbia University, has been appointed director of research at the newly created Institute of Child Welfare, of the University of California.

DR. CARL TEN BROECK, professor of bacteriology at the Peking Union Medical College, China, has been elected a member of the scientific staff of the Rockefeller Institute for Medical Research, and not to the board of scientific directors, as was incorrectly stated in an item reprinted in SCIENCE.

PROFESSOR G. RAMON, of the Pasteur Institute, Paris, is at present a guest research worker in the Connaught laboratories, University of Toronto.

PROFESSOR BERNARD NEBEL, of the University at Halle, is visiting the University of California, through an International Education Board fellowship. Professor Nebel spent previously six months in Geneva, New York.

DR. ANDREW M. MACMAHON, recently of the University of Chicago, is abroad for 1927–28 to study the subject of electrical conduction in solids with Professors Franck, Pohl and Born at the University of Göttingen.

DR. THOMAS A. JAGGAR, director of the U. S. Geological Survey station at the Mount Kilauea Volcanic Laboratory, in Hawaii, will lead an expedition to the Pavlof Volcano group of islands off the Alaskan Peninsula next April, according to an announcement by Dr. Gilbert Grosvenor, president of the National Geographic Society. The scope of the expedition next year includes the study of volcanology, physiography, wild life and botany. Complete plans for the work, and for the personnel, which will include specialists in these fields to be sent by the society, are not yet finished.

COLIN C. SANBORN, of the Captain Marshall Field Brazilian expedition, has returned from southern Brazil with further specimens of mammals, birds and reptiles for the museum.

NIELS NIELSEN, the Danish explorer, has returned to Denmark after an expedition to unknown parts of the interior of Iceland.

DR. ORLAND E. WHITE, formerly curator of plant breeding and economic plants at the Brooklyn Botanic Garden, has returned from Europe to assume his new work as professor of agricultural biology and director of the Blandy Experimental Farm at the University of Virginia. While in Europe, Dr. White read a paper on "Mutation, Adaptation, Temperature Differences and Geographical Distribution in Plants" before the Fifth International Congress of Genetics at Berlin.

DR. SVEN INGVAR, instructor in neurology at the University of Lund, has accepted an invitation to lecture this year at the Johns Hopkins University and has left Sweden for the United States.

DR. F. H. ALBEE, professor of orthopedic surgery at the New York Post-Graduate Hospital, has been invited by the Rumanian government to give a series of lectures and demonstrations, and is now on his way to Rumania.

DR. RUFUS I. COLE, director of the Hospital for Infectious Diseases of the Rockefeller Institute, gave on October 18 the first DeLamar lecture in hygiene before the School of Hygiene and Public Health of the Johns Hopkins University on "Acute Pulmonary Infections."

DR. JOHN C. MERRIAM, president of the Carnegie Institution of Washington, will address a meeting of the American Philosophical Society, Philadelphia, November 4, on "Science and the Appreciation of Nature."

A TABLET was recently installed at Williamstown, Vt., in honor of Thomas Davenport, blacksmith, pioneer inventor and builder in 1834 of an electric motor, to which a patent was granted which would cover, it is said, if still in force, every electric motor in existence.

A MEMORIAL service for Louis Agassiz Fuertes, whose accidental death occurred on August 22, was held on October 30 at Cornell University, with Dr. Livingston Farrand presiding. Dr. Arthur A. Allen, professor of ornithology; Romeyn Berry, graduate man-

ager of athletics, and Dr. Frank M. Chapman, curator of ornithology at the American Museum of Natural History, were the speakers.

A DINNER celebrating the one hundredth anniversary of the birth of Marcelin Berthelot was held in New York on October 25, at which Dr. John H. Finley presided. Other speakers included Ambassador Paul Claudel, of France; Dr. Charles H. Herty, technical adviser of the Chemical Foundation, and Dr. L. H. Baekeland. Coincident with the dinner, a ceremony honoring Berthelot was held in the Pantheon in Paris, at which many American universities and scientific societies were represented.

DR. W. GILMAN THOMPSON, emeritus professor of medicine at the Cornell University Medical College, died on October 27, aged seventy years.

DR. HOLMES C. JACKSON, dean of the New York University Dental College for the last two years and previously professor of physiology in the Medical School, died on October 25 at the age of fifty-two years.

DR. JULIA WARNER SNOW, associate professor of botany in Smith College and a specialist in freshwater algae, died on October 24.

DR. BENJAMIN DAYDON JACKSON, the British botanist, curator of the Linnean Collections, died on October 12, in his eighty-second year, following an automobile accident.

THE death is announced of Dr. Prenaut, professor of histology in the faculty of medicine at Paris.

THE second International Conference for Plant Protection has been scheduled to meet in November, 1928, to coincide with the ninth general assembly of the International Institute of Agriculture.

THE forty-fifth stated meeting of the American Ornithologists' Union will be held in Washington, D. C., from November 14 to 17, by invitation from the president of the union on behalf of the United States National Museum and the Washington members. The headquarters for the meeting will be at The Mayflower, where the business meetings also will be held. The public sessions will be held in the U. S. National Museum.

AN Organic Chemistry Symposium will be held at Columbus, Ohio, from December 29 to 31, 1927. The program will occupy the morning, afternoon and evening of each day. Only fifteen papers will be presented. Besides these there will be five colloquia on subjects of general interest to organic chemists. Those who will present papers were chosen by a general ballot of the organic division of the American Chemical Society last spring. They are as follows: Roger Adams, University of Illinois; Homer Adkins, University of Wisconsin; James B. Conant, Harvard University; Graham Edgar, Ethyl Gasoline Corporation; Wm. L. Evans, Ohio State University; E. C. Franklin, Stanford University; H. S. Fry, University of Cincinnati; Charles H. Herty, The Chemical Foundation; Arthur J. Hill, Yale University; C. S. Hudson, Bureau of Standards; Oliver Kamm, Parke, Davis & Co.; E. C. Kendall, The Mayo Foundation; J. A. Nieuwland, University of Notre Dame; James F. Norris, Massachusetts Institute of Technology; R. R. Renshaw, New York University.

THE Captain Marshall Field paleontological expeditions to Argentina and Bolivia, 1922–1927, have finished work in South America and are shortly returning to Chicago *via* the West Coast and Panama.

THE hunt for a fossil deposit in the mountains of Utah, lost for fifty years, has come to an end with the receipt by the Smithsonian Institution of a collection of fossil trilobites from Mr. Frank Beckwith, of Delta, Utah. One of the pioneer geological surveys which opened up the West more than a half century ago discovered in the House Range of Utah a deposit of excellently preserved fossil trilobites. These old collections are now in the Smithsonian Institution. In later years Dr. Charles D. Walcott, late secretary of the institution, revisited the region a number of times and tried to find more material, but did not succeed in finding the exact spot.

THE Richard Loeb unit of the Hopkins Marine Station at Pacific Grove, for which the Rockefeller Foundation provided $100,000, has been begun. It will be a concrete structure just west of the present main building. An interesting feature will be the outdoor salt-water tank, which will be built in such a way as to look like the rock on which the station stands, in order to interfere as little as possible with the appearance of the site.

THE American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, representing a membership of about 56,000 engineers, will join in giving to the University of Louvain a clock and carillon for its library tower as a memorial to American engineers who died in the World War.

A COLLECTION of four hundred and sixty-five engravings of famous old hospitals and distinguished surgeons from the seventeenth, eighteenth and nineteenth centuries has been given to the new University of Chicago Medical Schools by Charles B. Pike, of Chicago, who made a trip to Europe expressly to collect them. The university is collecting one hundred

portraits of leading contemporary physicians and surgeons to intersperse with the Charles B. Pike collection throughout the hospital. Dr. Frank Webster Jay, Evanston physician, has given the Frank Webster Jay collection of medical prints to the university for the hospital. Five hundred and fifty-five portraits, prints and autographed letters of distinguished physicians and surgeons are included in the collection.

PRESIDENT HAROLD S. BOARDMAN, of the University of Maine, has announced that the income from $100,000 bequeathed to the university by the late Thomas U. Coe, of Bangor, is to be used as a foundation for research, with the provision that such research work shall have some bearing on the development of the State of Maine. The faculty will suggest a list of research projects. The money became available to the university early this month.

A $1,000,000 foundation to assure perpetual effort toward making better leather through scientific research, has been started by the Tanners' Council of America. For five years the Tanners' Council laboratory has been maintained at the University of Cincinnati and the intent of the council is to make this laboratory a permanent institution and to stimulate leather studies elsewhere.

THE U. S. Bureau of Standards has announced the establishment of a research associateship in its textile section by the Cotton Textile Institute. The institute represents the cotton industry and the connection thus formed assures the proper functioning of the facilities of the bureau, in so far as cotton is concerned, along lines which will serve those most in need of authoritative data. The investigations mutually agreed upon are based primarily on the needs of the consumer. A. A. Mercier, who has been in charge of the experimental cotton mill at the bureau for a number of years, has been selected as a research associate for this work.

THE U. S. Weather Bureau has opened a third-order station at Cape Gracias, Nicaragua, to take the place of the one formerly in operation at Swan Island, West Indies, which was closed on August 31. The Tropical Radio Telegraph Company maintains a radio station at Cape Gracias, from which meteorological observations are now radioed twice a day. This service will operate the year round.

ACCORDING to the *Experiment Station Record*, headquarters for the Ohio-Mississippi Valley Forest Experiment Station, operated by the U. S. Forest Service as one of its regional stations, have been selected at Columbus, Ohio, in affiliation with the Ohio State University and the Ohio Agricultural Experiment Station. The region to be covered includes Ohio, Indiana, Illinois, Iowa, Missouri, western Kentucky and Tennesse and northern Arkansas, and a series of branch stations will be established in this territory. Field work has already been begun with a study of the growth of oaks in the vicinity of Portsmouth, Ohio. The initial appropriation of $30,000 will permit of a technical staff of five men. E. F. McCarthy, assistant director of the Appalachian Forest Station at Asheville, N. C., has been appointed director.

LARGER quarters at the Johns Hopkins University Medical School have been devoted to a study of causes of deafness; eventually, according to the *Journal* of the American Medical Association, it is planned to have the new enterprise reach the proportions of an independent clinic, and to extend the work to the whole field of maladies of the ear. The director of this work is Dr. Samuel J. Crowe, clinical professor of laryngology and otology; Dr. Stacy R. Guild is in charge of the laboratory. The Rockefeller General Education Board, members of the Dupont family and others have given financial aid.

A STATION at which useful insect parasites are kept and bred for the benefit of agriculture has been established by the Empire Marketing Board in London. Parasites are shipped all over the empire, wherever they are needed to destroy noxious insects or plants.

ACCORDING to a statement issued by the U. S. Department of Agriculture, the McKay Creek reclamation project reservoir, Umatilla County, Ore., together with small legal subdivisions of adjoining land, has been made a federal bird refuge by executive order. The refuge will be under the administration of the Biological Survey of the department. This reservoir, which is situated about six miles southwest of Pendleton, will provide a good resting place for waterfowl. Even though the refuge itself is not a specially good feeding ground, there are excellent feeding grounds in the adjacent region. The lands themselves included in the refuge are under the jurisdiction of the Department of the Interior for reclamation project purposes, and the reservation of them as a bird refuge is subject to the use thereof by that department, including leasing for grazing, and to any other valid existing right.

UNIVERSITY AND EDUCATIONAL NOTES

DR. CAROLINA S. RUTH ENGELHARDT has given $5,000 to endow a lectureship at the Woman's Medical College of Pennsylvania.

A $1,000 fellowship in mathematics has recently been established at Brown University by Mr. H. D. Sharpe.

THE psychological laboratory at Wesleyan University has moved into larger quarters, now occupying a floor and a half of Judd Hall. Dr. Carney Landis has been made acting chairman of the department and T. A. Langlie, formerly of the University of Minnesota, has been appointed instructor.

A COURSE in electrodynamics and atomic structure will be offered in the graduate school of the University of Pennsylvania this year by Dr. W. F. G. Swann, director of the Bartol Research Foundation.

THE North Dakota Agricultural College is organizing a new department of geology, of which Dr. John E. Doerr, formerly of Pennsylvania State College, has been appointed head.

GEORGE C. SHAAD, who came to the University of Kansas from the Massachusetts Institute of Technology in 1909 to be professor of electrical engineering, has been appointed acting dean of the school of engineering and architecture, to succeed the late Perley F. Walker.

DR. MOSES GOMBERG, professor of organic chemistry at the University of Michigan, has been appointed chairman of the department of chemistry of the university.

PROFESSOR W. C. RUFUS has returned from a year with the World Educational cruise to resume his regular work in the department of astronomy of the University of Michigan. Dr. Dean B. McLaughlin, of Swarthmore College, has been made assistant professor in astronomy. Dr. Allan D. Maxwell comes to the university from Lick Observatory and Dr. Hazel M. Losh from Mt. Wilson.

PAUL L. HOOVER, research fellow in electrical engineering at Harvard University, has been appointed assistant professor of electrical engineering at the Case School of Applied Science.

DR. CHARLES C. MOOK, of the American Museum of Natural History, has been appointed assistant professor of geology in the Washington Square College of New York University.

DR. H. M. HARSHAW, of the University of Missouri, and Dr. H. A. Pagel, of the University of Minnesota, have been appointed to instructorships in the department of chemistry of the University of Nebraska.

R. W. THATCHER, of Washington University, has been appointed instructor in geology at Oberlin College. Mr. T. J. Pettijohn, who has been instructor in geology at Oberlin for two years, is now holding a fellowship at the University of California.

T. G. B. OSBORN, professor of botany at Adelaide University and consulting botanist to the South Australian government since 1912, has been appointed to the chair of botany at the University of Sydney.

DR. TOM HARE, of the Lister Institute of Preventive Medicine, London, has been appointed to the chair of pathology at the Royal Veterinary College.

DISCUSSION AND CORRESPONDENCE

OLD PROBLEMS WITH NEW ILLUSTRATIONS

IT is a truism that the scientific investigator must find his reward largely in the joy of the work itself. Material compensation is not looked for, and even recognition is a secondary matter. It would seem, however, that this very fact makes it more imperative that any one writing a general article or a text-book covering a particular field of investigation be scrupulously careful to give full credit at least to the more prominent workers in this field.

Again, we all suffer from the effects of "newspaper science"; sensational articles written by irresponsible reporters. *Science Service* was organized to combat this evil. Does not this impose upon those engaged in scientific work the moral obligation to avoid sensationalism, exaggeration and loose statements in popular articles which they write?

These are not new questions; responsibility of writers to their colleagues, to the students who use their text-books, and to the general public is a matter that has been the subject of thought and discussion for many years. My recent reading, however, has led me to consider it anew.

The astronomer is aware that the late Professor James E. Keeler, by his brilliant work with the Crossley reflector, focussed attention sharply upon the advantages of this type of telescope for certain classes of photographic observations, and that in the course of his work he directed attention to the great number of the spiral nebulae (previously regarded as rather unusual objects) and to their significance in theories of cosmogony. The astronomer knows, too, that to Professor H. H. Turner, "more than to any other man, is owing the development by which photographic methods have become the most accurate and rapid of all ways of determining differential star positions." Again, he knows that Professor A. O. Leuschner has done quite as much as any man (in America at least) to develop modern methods of computing orbits of comets and minor planets, and to increase our knowledge of the motions of these bodies.

The astronomer, I say, knows these facts, but how is the student who uses a recently issued text-book in astronomy to find them out when Keeler is mentioned only in relation to the revolution of the Rings of Saturn and Turner and Leuschner are not named at all? These are but three of the more striking omis-

sions in this particular book. Some recent books on astrophysics are quite as badly at fault in this matter. One, for example, makes no mention of Huggins, Keeler, Langley or Vogel!

Again, every astronomer is aware that the total number of stars in our stellar system is an unknown quantity, though we arrive at *estimates* of this number by extrapolation. Thus,[1] in what is probably the most careful and reliable investigation of the number of the stars that has so far been made, it is said, "the *assumption* that these formulae [*i.e.*, the formulae which represent the number to the 21st photographic magnitude] also apply to the luminous stars *beyond observational reach* leads to 3×10^{10} [30 billion] as the total number of stars in the galactic system" (italics mine). He knows that *measures* of stellar diameter are possible at present only by means of the interferometer and that these diameters when given in linear units (miles or kilometers) depend in part upon the adopted distance (parallax), which may be uncertain by 25 per cent. or more of its total value. *Antares*, for example (which is the largest star of measured diameter, unless, perhaps, *Mira Ceti* slightly exceeds it), has a diameter of 280,000,000 miles on the basis of one assumed parallax, and of 430,000,000 on the basis of another, the former being probably (but not certainly) the more reliable.

But in a recent popular article, printed in a journal of high standing and later reissued as a reprint by the observatory with which its author is connected, we find the categorical statements: "Our Milky Way system contains about fifty billion stars," and, a star is "a sphere of glowing gas varying in size from a globe not much larger than the earth to one *a thousand times larger* (italics mine) than the sun in diameter," *i.e.*, more than 860 million miles, or double, possibly treble, the value of the star of largest measured diameter.

The author also remarks blithely that "fifty billion years is but a short interval in the life of the average star," which may (or may not) be true, but is certainly not a demonstrated fact. Furthermore, he lets the reader infer, as a friend pointed out to me, that the Magellanic Clouds have recently moved so far north that their radial velocities can be and have been measured from Mount Wilson or Flagstaff!

The question is this: Is it quite fair to the intelligent public to give the impression, which the average reader will certainly gain from this article, that these figures and dimensions are matters of knowledge and on the same footing as our knowledge of the distance to the sun or of its diameter? Does not the writer of such an article owe it to his reader to make it clear that some of his results rest upon theories, assumptions and extrapolations, all of which, though they may now seem to us to be well-founded, may be subject to revision—possibly even to rejection—in the light of further investigation?

Finally, to revert to my opening paragraph: while every scientific investigator is concerned primarily with the advancement of knowledge, and not with his own fame, is it not his due to be given recognition for his work in books that record for the student the chief steps in the development of his science?

R. G. AITKEN

[1] "Mean Distribution of Stars according to Apparent Magnitude and Galactic Latitude," by F. H. Seares, P. J. van Rhijn, Mary C. Joyner and Myrtle L. Richmond. *Contrib. Mt. Wilson Obs.*, No. 301, 1925.

ON MANSON'S EYE WORM IN POULTRY

IN certain sections of Florida, especially the seacoast areas, quite severe outbreaks of Manson's eye worm (*Oxyspirura mansoni*) in poultry occur each year, occurring most frequently during the rainy season of the summer months. Due to its economic importance, and also since its life history was unknown, a detail study of the parasite was begun in November, 1925, by Dr. D. A. Sanders, of the veterinary department, Florida Agricultural Experiment Station.

The first experiments conducted were simply exposure tests to determine if the parasite would pass from infected to non-infected birds kept under continuous exposure. It was impossible to transmit the parasite by simple exposure of non-infected to infected birds.

Experiments were conducted in an effort to produce infection by placing eggs containing embryos of the parasite into the eyes of non-infected birds. It was impossible to produce infection in this manner.

It was also found impossible to produce infection by placing newly-hatched larvae into the eye of non-infected birds.

From the above-mentioned experiments, it was quite apparent that an intermediate host was necessary in the development of the life cycle of Manson's eye worm. Search for the intermediate host was begun, and this search included examinations of many of the insects most commonly found around the premises of the poultry flock. After examining many insects, finally specimens of *Pycnoscelus* (*Leucophaea*) *surinamensis* Linn., a species of cockroach, were examined and encysted larvae of the eye worm were found in the body cavities of some of these roaches. Larvae were taken from the infected roach, and when placed into the eyes of birds, these larvae remained therein and produced infection. Larvae were taken from the body of a roach and placed into the mouth cavity of non-infected birds with the result that

shortly afterwards, the birds showed infection of Manson's eye worms. Whole roaches were fed to non-infected birds with the results that within twenty to thirty minutes after the birds had eaten the roaches containing larvae, the parasites had reached the eyes of these birds.

The results obtained by Sanders in Florida confirm the work of J. W. Fielding as reported in *The Australian Journal of Experimental Biology and Medical Science* Vol. III (1926) that *Pycnoscelus* (*Leucophaea*) *surinamensis* is the intermediate host for Manson's eye worm of poultry. However, the work of Sanders in finding this intermediate host was done independent of Fielding's work.

The mature parasites are located in the tear sinus just beneath the third eyelid or nictitating membrane. In some cases, birds harbor only one or two parasites, while in a severe infection as many as fifty or more parasites may be present in the eyes. The mature parasite is 14–18 mm. in length and thread-like in diameter.

It is possible to infect many different kinds of wild birds by feeding them infected roaches.

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RE NOMINA CONSERVANDA

EVEN after being so professorially lectured in SCIENCE[1] in an article which could more appropriately have appeared in the same medium as did the paper it attacks, the writer wishes to reply only to the extent of clearing up possible misapprehensions in the minds of readers.

By implication the writer is classed with those having the "mihi itch" in an objectionable form. He would state therefore that his object from his very first paper on entomological taxonomy has been to do essentially revisional work that would have a maximum of teaching value to younger entomologists and be a real aid to identification of species in the hands of more advanced students. To date he has been sole or joint author of fifty-two articles dealing with the classification of insects and thirty-nine of these are revisional in scope or at least include keys. The piling up of mere descriptions of new species has never been his object; but on the contrary is an activity he heartily condemns. At the same time he believes that personal interest in achievement is no more lacking in taxonomic work than in other fields of human endeavor, and that this is only as it should be, altruistic platitudes to the contrary notwithstanding.

[1] Bradley, J. Chester, 66, 100–103, July 29, 1927.

Professor Bradley insists on the separability of taxonomy and nomenclature, but passes over the writer's suggestion that a code of vernacular or other names could be used by general biologists that would have no necessary connection with technical taxonomy.

Bradley's reference to general zoologists, morphologists, etc., riding rough shod over taxonomists is certainly well put, for just that is what has been attempted in the making of nomina conservanda. Taxonomists deal constantly with morphology and use morphological terms almost as much as the morphologists themselves, yet they have not attempted to dictate standardization of anatomical terms, new ones of which are constantly being introduced. Taxonomic nomenclature is no more the language of science than is anatomic nomenclature and is no more subject to dictatorial rule.

Bradley ends on a note of not becoming a slave to rules, which he may be sure finds an echo in the breasts of men so individual and independent as taxonomists usually are. They desire to be the slaves neither of rules nor of rulers (*i.e.*, of Committees and Congresses).

W. L. MCATEE

EARTHWORMS AND SPECTRAL COLORS

THE article by W. R. Walton on "Earthworms and Light" in SCIENCE for August 5, 1927, recalled to me some research I did in this line some years ago but did not publish.

For the experiment I used a box about two and a half feet long, two feet wide and eighteen inches high. This I thoroughly blackened inside. For light I used gas with a mantel and a reflector. The light was passed through a carbon-di-sulphide prism. The light fell on a white paper in the bottom of the box. Into this array of spectral colors I dropped angleworms. As they moved to get away from the light they always went out the red end. They would pull back from the blue as if it hurt them and turn toward the red. This reaction occurred with every worm except one. This worm lay full length in the green and stayed there. I was not able to repeat this last reaction.

G. H. BRETNALL

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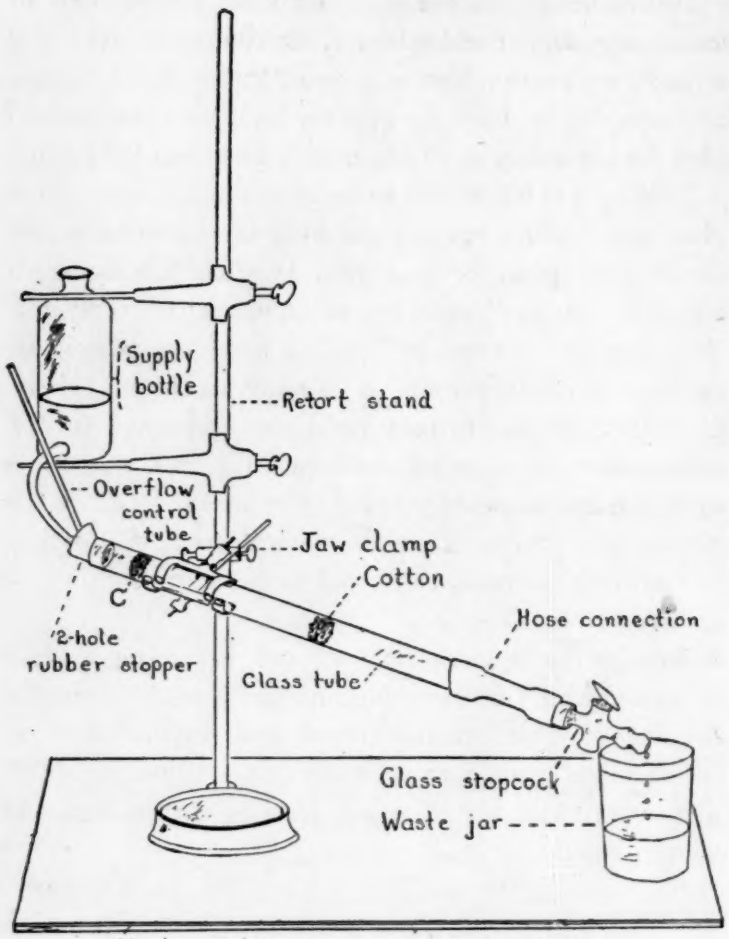
SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE AUTOMATIC DEHYDRATING APPARATUS FOR MANY SMALL OBJECTS

THE accompanying figure represents a very satisfactory apparatus for changing fluids on many small objects. It grew out of the need for saving time in handling ovaries of mice. It is essentially a glass



Automatic device for changing fluids on many small objects

FIG. 1

tube about 300 millimeters long by 16 millimeters inside diameter supported at an angle of about 30 degrees, fitted with a glass stopcock at the lower end and with a 2-hole rubber stopper at the upper, through which fluids are conducted from the supply bottle. The overflow tube fitted into the rubber stopper serves two purposes. When the large glass tube is being filled from the supply bottle, it allows air to escape; and also prevents overflow when the tube is full and the stopcock closed. A retort stand fills all the needs of a support, if fitted with rings and clamps as shown in the figure. Other means of support are readily devised. The supply bottle is of the aspirator type.

As used by the author, each ovary is put into a short piece of small glass tubing, the ends of which have been smoothed on a small emery wheel. The corresponding number is written in pencil on a small strip of paper and placed with the ovary in the tube, which is then wrapped in a piece of loosely woven cotton cloth, fastened at the side by either thread or fine copper wire, leaving only one layer of cloth over each end of the tube. Many of these small tubes, each with its numbered ovary, are placed in the large glass tube which is filled with the appropriate fluid, clamped in place, connected to the supply bottle as shown, and the desired fluid allowed to flow in. For example, if the next step is to pass from 30 per cent. to 95 per cent. alcohol, this latter fluid is placed in the supply bottle, and the glass stopcock adjusted to a very slow rate of dropping, perhaps one drop per second. The 95 per cent. alcohol passes very slowly into the tube at the upper end, is diluted and the mixture gradually works its way downward. Ultimately the tissues are in 95 per cent. alcohol. By placing a small loose wad of absorbent cotton at the two places indicated in the figure (C and cotton), it was seen by admitting colored alcohol from the supply bottle into water or a low grade of alcohol in the glass tube, that the front of the new mixture moved evenly, thus proving that all the objects in the glass tube would be affected serially from top downward.

It is wise not to put tissues between the upper wad of cotton (C) and the 2-hole rubber stopper, as the amount of fluid contained in this space allows mixing of the two fluids, which prevents too sudden a change on the upper pieces of tissues. The large glass tube holds about fifty of our small glass containers, which measure about 15 mm. long by 5 mm. inside diameter. These are easily cut in the laboratory. The large glass tube and the small containers may be varied in size according to the needs of the user; but it is likely that if the large tube is much greater in diameter the flow of the fluid might be difficult to control evenly. Several tubes may be filled and joined end to end for simultaneous treatment.

The inflow may be checked at any time by closing the glass stopcock. Tissues may remain immersed any length of time in a particular fluid without loss of fluid by evaporation. They may be fixed, washed, stained, dehydrated and cleared without further handling. So far as the author can see, this device is as reliable as an air current or a mechanical agitator. The user will realize the necessity of a very slow movement of fluids. The dropping may be regulated to any rate desired, from less than a drop per second to as many as may seem best. The clearing fluid should probably be added more slowly than the alcohols, and be started in a mixture with 95 per cent. or 100 per cent. alcohol. In placing the small containers in the large glass tube, one should avoid closing either end by contact with another surface. Small animals and some hard tissues may be kept separate by mosquito netting or cloth sacks only.

If the apparatus is used for staining it is well to make new paper labels before infiltrating the tissues with paraffin, as pencil marks are likely to be dimmed if the stain remains in the paper, and consequently difficult to read when covered with paraffin. Paper labels may be avoided by numbering the small glass tubes and keeping complete corresponding records.

Used fluids may be preserved, account being kept on the labels of the number of times used.

EZRA ALLEN

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SPECIAL ARTICLES

SURVIVAL OF ABILITY

HAVING found from two different sources unmistakable confirmation of an earlier research of mine showing that mental evolution is going on to-day through a process of natural selection, I would like to present briefly the results, as the full publication may be for some time delayed.

It is often stated that there are now no forces at work to lead towards increase of brain power, because the primitive struggle for existence has ceased to be operative under present conditions of civilization, in which the weak and incompetent are bolstered up and the poor and shiftless are allowed to have many offspring.

It appears, however, that society is being divided into two classes, a small percentage of "aristocrats" and a large percentage of proletariat.[1] Within the so-called aristocracy there is taking place a genuine process of survival of the fittest in which the more ambitious, successful and intellectually eminent are having a larger number of children than their friends and relatives who are less well endowed.

In studying the royal families of Europe I found this to be the case (see "Heredity in Royalty," 1906). Now I have found it to be the same among Harvard graduates and also in the British peerage.

Mr. A. E. Wiggam, writing in the *World's Work* for November, 1926, page 32, makes comment upon the figures for Harvard graduates, which I sent him as confirmation of a belief I have held for twenty years that by-and-large all good human qualities are correlated and therefore mental evolution must continue. Also such facts give an added justification for eugenics and a brighter outlook for the future of mankind. This point of view is contrary to the attitude of Conklin, Pearl and Castle if I interpret their writings correctly, but is accepted by Thorndike; and I think by Terman judging from this same article by Wiggam.

This announcement of mine regarding Harvard graduates has apparently stimulated a number of people to look up the records and see if it be true. This I gather through correspondence. John C. Phillips writes me that he is finding confirmation. No figures have as yet been published. Those which I possess are for only four graduated classes, '90, '92, '94 and '98. I had hoped to include '96 for the sake of symmetry but the figures as they stand are sufficient to make the conclusion almost certain that judged by the oft-used standard of success, "Who's Who in America," the graduates who are parents of three or more children are a little more likely to be in "Who's Who" than those with less and much more likely than the bachelors. All figures are taken from the class books made up on the twenty-fifth anniversary after graduation, which books have at least the appearance of approximately sufficient care, accuracy and completeness.

PERCENTAGES OF HARVARD GRADUATES IN "WHO'S WHO IN AMERICA," 1924–25

Number of Living Children

	Unmarried	0	1	2	3	4 or more
Class of '90	15.2	19.40	22.92	18.27	24.45	14.26
" " '92	14.75	14.10	18.75	22.81	20.76	18.92
" " '94	6.25	20.0	13.33	18.07	22.45	25.45
" " '98	2.63	12.26	12.64	8.0	8.0	13.73
Averages	9.71	16.44	16.91	16.79	18.92	18.09

It can be seen from the figures that no one would suspect from the data regarding any single class, that any such truth lay buried. Take the Class of '90, for instance, which was the first investigated. Here the unmarried have actually a higher percentage of inclusion in "Who's Who in America" than those with four or more children. The grand average, however, smooths the curve out, giving the two highest percentages at the right, 18.92 and 18.09, with the lowest at the left, 9.71, for the bachelors. The remaining figures are satisfactory though the rise is not perfectly uniform. If we add the percentage of the bachelors to the married without children, and divide by two we get 13.08 for the childless compared with 16.+, 16+, 18+, 18+ for the other four groups. The total number of individual cases studied is well over 1,000, which is the number usually necessary in correlation investigations.

This confirmation of the results from the royal families led me to believe that the same truth would undoubtedly be found in the records of the British peerage, namely, that the more notable or able, are (within any one homogeneous social class), the ones who have the largest number of living children. The well-known "Burke's Peerage" is an exceedingly complete and accurate book. I have divided all the peers (Edition of 1921) into two groups: first those whose male lines are traceable as early as 1450, and second,

[1] See F. A. Woods, "Social Conification," in Proceedings of Second Eugenics Congress, 1921. Published in "Eugenics, Genetics and the Family," 2 vols., Baltimore, Md.

those whose male lines are not traceable to such an early date. This bears on the average some relationship to the date of elevation to the peerage, but that is another matter.

These in the first group are the peers who belong to the very old families, so-called. They constitute about half of all the peers. Their family names are well known to everyone conversant with English history.

As regards their achievements, which must be in a considerable degree due to a mixture of ability, vitality and ambition, they have all been placed in two groups. First, a comparatively small group who have done nothing or next to nothing in the way of rendering public service and, second, a majority group whose public services appear to have been both genuine and continuous. Naturally there are border-line cases difficult to place, but these are not very numerous and I have been careful to place the doubtful cases in such a way that they would count against rather than in favor of my theory. Only those over 34 years of age have been included.

All who have been elected members of parliament or risen in the navy to the rank of commander or colonel in the army (not honorary colonel), also those who served in the great war, have been included in the "service" group as well as the few business and professional men. Both "Burke" and "Who's Who" have been consulted for each case. Generally speaking if there is anything in their biographies that can be called "service" they have been included in this group.

In spite of this liberality of inclusion in the "service" group there are about 68 among the peers of the newer families whose achievements appear to be either nothing at all, or very inconsiderable. These have 138 living children, which gives an average of 2.03.

There are about 274 peers of the newer families who come within the "service" group. These have 640 living children or an average of 2.33. An even greater rise is to be found in favor of the greater fecundity of the peers who have rendered "service" when we summarize the facts concerning the older families. Here about 70 peers with little or no public service to their credit have 131 living offspring or an average of 1.87, while 210 "service" peers have 610 living children. The average for living children here rises to the surprising height of 2.90.

The English peers evidently want children and they have them. The best among them apparently want them the most, so that in spite of the large number of sons killed in the war, this special caste of humanity is more than holding its own.

Dr. J. McKeen Cattell and others have shown that parenthood to-day is largely a voluntary matter, at least among the more intelligent classes. The desire for children is doubtless in part an instinct and as far as it is an instinct should be subject to hereditary transmission. It is in all likelihood correlated with such virtues as domesticity and stability. It appears from these figures to be also correlated directly with intelligence and ambition. When we reach the type of ability generally called genius there is again a falling off in the number of offspring, but it is a matter of satisfaction to know that within the different groups of humanity there is by-and-large a survival of ability.

The average for total offspring for all college graduates is lower than it ought to be to keep up the type. For all Harvard graduates it averages below two. Some may say, "What is the use of survival of ability when if this goes on long enough there will not be any ability left to survive." The answer to this is a long one and can only be indicated here. Voluntary parenthood is a recent phenomenon. The average for all graduates, *circa* 1.5, rises for the more successful to *circa* 1.6. As nowadays only those who want children have them, the children should themselves inherit this temperament. This is a new condition which did not exist until recently. From now on this inheritance of the parental instinct should in a few generations restore the number to a little over two, which is necessary for a continuance of the breed.

It is true that the people of the slums are having undesirably large families, but this class is now almost entirely separated as far as intermarriage is concerned from the upper classes—more so in England than in the United States, but increasingly so on both sides of the Atlantic. It is probable that an intensive study of families within the slums where brother could be compared with brother and sister with sister would show the same result, namely, the better members of the family having the largest number of surviving offspring.

FREDERICK ADAMS WOODS

QUANTITATIVE HYDROLYSIS OF STARCH BY BUFFERED TAKA-DIASTASE

THIS work represents an attempt to eliminate the use of acid hydrolysis in determining the starch content of plant material.

The standard method is the "maltose hydrolysis." This consists in treating the alcohol extracted materials with taka-diastase in water solution, filtering off the insoluble residue, and heating the filtrate with dilute acid to hydrolyze the dextrin and maltose to

glucose. The glucose content of the solution may then be determined by any standard method.

This procedure is open to criticism in that the water extract will contain any water soluble substance originally present in the material unless it was dissolved out by the alcohol. Since pentosans are insoluble in alcohol and soluble in water they may be present in the water extract. These, if present, would be hydrolyzed to reducing sugars by acid, and recorded as starch.

It is, therefore, desirable to use, if possible, a hydrolyzing agent more specific than acid. Enzymes in general are specific in their actions, and taka-diastase is the most efficient of the enzyme mixtures which attack starch. Much work has been done upon the optimum conditions for enzyme activity. The optimum temperature range for taka-diastase is 30°–40° C.[1] The optimum pH is 4.5–5.0.[2] The hydrolysis curve begins to flatten at 50 hours[3] and .2 gm. of enzyme is sufficient to dissolve .5 gm. starch.[4] Most of this information is in Waksman and Davison, "Enzymes," but curiously, data could not be found indicating that any one had put it all together. Kuhn[5] reports a curve for the hydrolysis of starch by taka-diastase at pH 4.5 for 50 hours at 36° C. in which he obtains 71.4 per cent. hydrolysis. He used 2 cc. of .5 per cent. enzyme solution for .603 gm. starch, so that it is probable that the quantity of enzyme was the limiting factor in that experiment. Horton[6] working with unbuffered solutions reports that it is impossible to obtain consistent results with taka-diastase. In this laboratory, when 50 cc. of .3 per cent. starch solution was held at 40° C. for 36 hours with 1 cc. 10 per cent. taka-diastase and 5 cc. acetate buffer (pH 5.0), glucose values representing 98.5–101.1 per cent. hydrolysis were obtained consistently.

The substrate was potato starch which had been purified by repeated washings with distilled water and dried in a vacuum oven at 120° C. over phosphorus pentoxide to constant weight.[7] The starch was not caramelized by this treatment. Furthermore, the analysis of undried starch of known moisture content gave concordant results. The reducing sugar was determined by the Schaffer-Hartmann[8] modification of the Munson-Walker method. The amount of reducing sugar produced by a maltose hydrolysis on another aliquot of the same solution was taken as the standard of complete hydrolysis.

Reducing the concentration of taka-diastase to ¾ did not decrease the amount of glucose formed, and ½ the amount of enzyme gave 95.6–99.0 per cent. glucose. It was impossible to obtain consistent results at pH other than 4.5–5.0 with acetate buffers. A phosphate buffer at 4.5 gave 100.1 per cent. glucose.

In view of the present interest in the structure of starch it is interesting to note that both acid and enzyme hydrolysis consistently gave results equal to 93 per cent., the dry weight of the sample. It is possible that the starch was impure and contained only 93 per cent. hydrolyzable material. Davis and Daish[9] working in England, report that acid hydrolysis of potato starch gives 93.8–94.5 per cent., the theoretical amount of glucose. They attribute the low results to destruction of glucose by the prolonged treatment with acid. If the enzyme hydrolysis be inaccurate, the fault probably lies in incomplete hydrolysis and the establishment of an equilibrium between dextrin, maltose and glucose. It seems improbable that this equilibrium point should coincide with the point reached by the destruction of glucose by acid hydrolysis. Noyes[10] says that the analytical ratio between starch and glucose is .93. The agreement between these three figures may be coincidental, but the point should be further investigated.

The method seems to give concordant results with pure starch, and one series of determinations on grape wood gave values identical with those obtained by the maltose hydrolysis, but the method needs more work before it can be considered reliable. The specificity of taka-diastase for hexonsans should be more carefully investigated. It is also possible that the time required for a determination may be shortened by the use of more concentrated enzyme solutions, or a different temperature.

I. D. COLLINS

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[1] Euler, Chemie de Enzyme (Waksman); Kuhn, R.; Berichte der Chem. Gesell. 1924, 57: 2, 1965.

[2] *Ibid.*

[3] *Ibid.*

[4] This laboratory.

[5] Kuhn, R.; Berichte der Chem. Gesell. 1924, 57: 2, 1965.

[6] Horton: *J. Agr. Sci.*, 1921, 11: 240.

[7] Walker: *J. A. C. S.*, 1907, 29: 54.

[8] Schaffer and Hartmann: *J. B. C.*, 1920–21, 43: 371.

[9] Davis and Daish: *J. Agr. Sci.*, 1914, 6: 152.

[10] Noyes: *J. A. C. S.*, 1904, 26: 266.

THE NATIONAL ACADEMY OF SCIENCES

(*Continued from page 406*)

Studies in animal aggregations; protection of the individual by the mass: W. C. ALLEE (introduced by Frank R. Lillie). The injurious effects of crowding are easily demonstrated and have received due attention. Beneficial results from aggregations of animals without apparent social organization have escaped notice until recently,

when group survival value has been demonstrated for various land isopods and for the brittle starfish, Ophioderma, under starvation (Allee); for many animals when exposed to toxic reagents such as colloidal silver (Drzewina and Bohn, Bresslau, Allee and Schuett); and for certain marine turbellarians when exposed to hypotonic sea-water (Drzewina and Bohn). Groups of starving individuals show a modified rate of oxygen consumption as compared with wholly similar isolated animals. This appears to be correlated with changes in muscular tonus. Two explanations have been advanced for the protection furnished by numbers in toxic solutions: Drzewina and Bohn postulate an autoprotective secretion which enables the animals comprising the group to withstand the toxic action better than isolated individuals. The other workers find that with many reagents a large part of the protection is due to the greater fixation, by absorption or otherwise, of toxic material by the group. This leaves open the question of the production of a protective substance. Recent critical experiments demonstrate that the marine turbellarian, Procerodes, lives longer when a number are transferred to tap-water than do similar but isolated individuals in the same amount of tap-water. The greater survival value of the group is not wholly due to greater salt transfer, for greater protection is furnished by the filtrate from groups than by tap-water containing a larger amount of sea-salt. The protective material is given off both by living and by dead animals and once in solution will pass through ordinary filter-paper and will persist after the filtrate is brought to a boil. The results confirm the author's earlier suggestion of the existence of methods of integration in ecological animal communities more subtle than the food and space relations usually considered, and demonstrate a mechanism of cooperation among individuals comprising even loosely integrated animal aggregations.

The influence of a changed environment in the formation of new species and varieties: FRANK COLLINS BAKER (introduced by S. A. Forbes). In Barron County, Wisconsin, near Chetek, a series of small creeks and rivers were transformed into a number of large, shallow lakes by building a dam which ponded the waters for a distance of some eleven miles. The lakes were completed some sixty years ago for lumbering operations. The original molluscan inhabitants of this region were creek and small river species. Those mollusks that remained above the dam were quickly transferred from a creek habitat to a lake habitat. Many of these, such as the naiads, *Fusconaia, Elliptio Lasmigona* and *Strophitus,* as well as the gastropod, *Campelona,* either migrated upward to the remaining part of the creeks, Moose Ear and Pokegoma, where the fauna was unchanged, or became exterminated. Certain other species of both naiades and gastropods, *Anodonta grandis plana, Lampsilis siliquoidea, Amnicola limosa, Stagnicola catascopium, Helisoma antrosa* and *Helisoma trivolvis,* remained in the newly ponded waters and in the course of sixty years have become modified into recognizable varieties, several of which occur widely distributed in the lakes formed after the retreat of the ice following the Wisconsin stage of glaciation. The changes in the form of the shell resulting from the change in environment have been, in the naiades, a shortening of the shell and an increase in obesity, and in one case, *Lampsilis,* of a greatly increased height. In the gastropods, *Amnicola, Helisoma, Stagnicola,* the result has been an inceased globoseness and a widening of the umbilical region, in short, a loosening of the coiling of the whorls, whereas in the creek forms the whorls are coiled more tightly, leaving a smaller umbilical perforation. The result of this unintentional experiment, conducted on so large a scale and during such a long period of time, is conclusive proof, it would seem, that the environment does have a modifying effect on such plastic animal life, the degee of differentiation varying with the inherent variability of the organism. What has taken place in the Chetek Lake region is without doubt similar to the changes that occurred in the animal life of the waters following the different glacial invasions of the Ice Age, when the life, which has been driven southward by the ice, returned after its recession to find, instead of river systems, like that now existing in the Driftless Area of Wisconsin and Illinois, a vast system of lakes, which it invaded and in which it changed from one species or variety to another by the process of small variations like those shown to have taken place in the Lake Chetek region during a period of less than a century.

Energy metabolism as related to the plane of nutrition of cattle: E. B. FORBES. A study of the economy of utilization of the energy of feed by cattle was made at the Pennsylvania Institute of Animal Nutrition by means of a respiration calorimeter. This calorimeter, which is the only such apparatus in the world of the size necessary for large farm animals, permits of the direct measurement of the heat given off by the animal, as well as the determination of all factors of material outgo. In a duplicate series of energy balance studies with two steers, at five planes of nutrition, from fast to full feed, it was shown that the loss in heat per unit of weight of feed (the heat increment), increases with each increase of feed, but the rate of increase in heat increment is such as to be expressed not by a straight ascending line but by a curve falling from such a line. By the subtraction from the gross energy of the feed of all losses and expenses of utilization—namely, the potential energy of the visible excreta and of the methane produced by fermentation in the paunch, and the increased heat loss due to the consumption of the feed, the net energy available to the animal for maintenance and body increase was derived. The total net energy per unit of feed was found to decrease in a simple proportional manner with increase in feed; but in order to be able to compute separately the feed requirements for maintenance and production, for guidance in feeding practice, it is necessary to determine separate net-energy values of feeds for these purposes. Using the heat production of the fasting animal as the measure of the maintenance requirement of net energy at all planes of nutrition, it is proposed that one net-

energy value be used as the basis for computing the entire maintenance requirement of feed. Then a second lower net-energy value would represent all feed used for body increase. Net-energy values of alfalfa hay and corn meal, for maintenance and for body increase, computed by a new procedure, are presented.

The origin and destiny of prairies: HENRY C. COWLES (introduced by John M. Coulter). Many theories have been advanced to explain the treelessness of prairies. None of these has been generally accepted as adequate, and yet it is likely that most of them have some degree of validity. One of the major difficulties has arisen from lumping together prairies of many sorts and seeking a common explanation for them all. In this paper the attempt is made to sort out the major prairie types into three groups, which may be called climatic types, edaphic types and tension line types. The edaphic and tension line prairies are regarded as having a forest density, but the climatic prairies are believed to be more permanent. Recent soil studies show interesting interchanges between prairies and forests, and shed much light on various aspects of the prairie problem.

Reflection of light from the surface of leaves: CHARLES A. SHULL.

The isolation of a crystalline protein with tuberculin activity: FLORENCE B. SEIBERT. In the case of tuberculin, as with other biologically active principles, toxins, etc., there has always been the question as to whether the specifically potent factor is a protein or merely an infinitesimal amount of some very highly active substance attached to the protein. The difficulty in solving these problems has been due to the fact that the purification of proteins is one of the most difficult chemical tasks there is. Many previous investigators, beginning with Koch himself, have thought the active principle of tuberculin, which is responsible for the skin reaction in tuberculous subjects, was protein and all of the evidence from our laboratory during the last three years, *i.e.*, experiments based upon chemical analyses, dialysis, precipitation and hydrolysis, have consistently confirmed this view. Chief among the evidences is the fact that when the water-soluble protein obtained from tuberculin, that had been made in a non-protein medium, is treated with the proteolytic enzymes, pepsin and trypsin at the proper reaction, there is a loss in biological activity, paralleling a chemical break-down in the whole protein molecule to proteoses, peptones and amino acids. This evidence, together with the fact that the water-soluble protein, when not denatured, will crystallize into needles or burrs which after five or ten recrystallizations are still potent biologically, would seem to leave very little further doubt as to the protein nature of the active principle. The protein is crystallized by Hopkins' method for crystallizing ovalbumin at an optimum hydrogen-ion concentration point of pH 4.9. One lot of crystals, after fourteen crystallizations with solution in distilled water and filtration through hardened filter-paper between each crystallization, gave the following protein tests. They were heat coagulable, gave positive biuret, Millon's, vanillin, ninhydrin and glyoxylic tests, a negative Molisch test and stained blue with methylene blue. The crystalline protein is purer and therefore more potent than the original water-soluble fraction of tuberculin from which it is made, as indicated by the following test. One tenth of a milligram of the original fraction is required to produce a maximum skin reaction in tuberculous guinea pigs, whereas, of the protein obtained from it and recrystallized ten times, as little as 0.04 mgm., measured as coagulable protein, sufficed to give an equally strong reaction. Throughout the experimentation evidence has accumulated for the following interpretations. The protein in tuberculin in its most natural and unchanged form, is crystallizable into needles and burrs, but it is an extremely labile protein very readily becoming less soluble in distilled water and then not crystallizable. This less soluble protein is still biologically active, but loses all or most of its activity with a further change to complete insolubility in distilled water. This denaturization and instability of the protein in water explain the small yield of crystals obtained and the great losses in activity during isolation of the protein and emphasize the importance of using the quickest and least drastic methods possible when the highest yields of most potent material are desired. In the case of tuberculin, therefore, there seems to be sufficient evidence to warrant the conclusion that the active principle is protein. It is a specifically toxic bacillary product and a protein obtainable in crystalline form, thus passing the first criterion of purity from a chemical standpoint. This work has been aided by a grant given to Dr. E. R. Long by the National Tuberculosis Association, for whom the H. K. Mulford and the Parke, Davis Co. have supplied the tuberculin in large quantities.

Are arginine, glutamic acid and aspartic acid necessary components of the diet during growth? W. E. BUNNEY and W. C. ROSE. In continuation of the investigations in this laboratory regarding the nutritive importance of the amino acids, growth studies have been made with diets practically devoid of (a) arginine, and (b) arginin, glutamic acid, and aspartic acid. The nitrogenous portion of each ration consisted of hydrolyzed casein from which the amino acids in question had been precipitated by appropriate methods. White rats have been maintained for periods of 100 days upon food mixtures containing the modified casein at levels of 12 and 9 per cent., respectively. During these periods excellent growth occurred. Animals which were furnished the 12 per cent. rations grew at a perfectly normal speed, while those which received the 9 per cent. diets increased in weight at a slightly subnormal rate. That the less rapid growth under the latter circumstance was not due to a deficiency of arginine, glutamic acid or aspartic acid is shown by the fact that the incorporation in the diets of the amino acids in question entirely failed to accelerate growth. The above results point very strongly to the conclusion that arginine, glutamic acid and

aspartic acid are probably not indispensable for normal nutrition. On the other hand, this fact does not exclude the possibility that some other component of the protein molecule may assume vicariously the functions of the missing amino acids. The chemical similarity of proline, glutamic acid, and the ornithine portion of arginine suggests that these three compounds may be closely associated physiologically, or even interchangeable in metabolism. This possibility is being investigated.

Relationship between the structure and bactericidal properties to B. Leprae of certain organic acids: ROGER ADAMS and associates (introduced by W. A. Noyes).

Power series expansions in the neighborhood of a point on a surface: ERNEST P. LANE. In ordinary space an analytic non-ruled surface referred to its asymptotics may be defined, except for a projective transformation, by a completely integrable system of partial differential equations in Fubini's canonical form

$$x_{uu} = px + \vartheta_u x_u + \beta x_v, \quad x_{vv} = qx + \gamma x_u + \vartheta_v x_v, \quad \vartheta = \log(\beta\gamma).$$

The four homogeneous coordinates of a point on such a surface referred to the covariant tetrahedron x, x_u, x_v, x_{uv}, with suitably chosen unit point, are such that, if the ratios of the first three of them to the fourth are denoted by x, y, z, there exists an expansion of the form

$$z = xy - \tfrac{1}{3}(x^3 + y^3) + \ldots$$

This paper presents a new method for calculating the coefficients of this expansion to as many terms as desired, and computes for the first time the coefficients of the terms of the fifth order. Then various geometrical applications are made. Since every term of the series is an absolute invariant it is easy to show how to write the equations of many curves and surfaces covariantly connected with the original surface and the geometrical nature of this connection is explained. In particular the algebraic surface of order n obtained by truncating the series after degree n, which is a generalization of the canonical quadrics and cubic surfaces used by Wilczynski, Green and Fubini, is characterized geometrically.

Groups generated by two operators of order three, the cube of whose product is invariant: G. A. MILLER.

Non-monogenic functions (by title): EDWARD KASNER.

Multiply transitive groups of prime-power degree: R. D. CARMICHAEL (introduced by G. A. Miller).

On a property of frequency distributions of the powers and roots of variates of a given distribution: H. L. RIETZ (introduced by G. A. Miller).

Geometric properties of triple systems: A. EMCH (introduced by G. A. Miller).

On the theory of ideals in an algebra of finite order: G. A. WAHLIN (introduced by G. A. Miller).

Light quanta and interference: A. J. DEMPSTER. The reconciliation of the interference of light with the quantum theory of atomic processes leads to great difficulties. Hitherto no experiments have been made in which the light from a single atomic emission was examined. In this paper interference experiments are described in which only one atom at a time was excited. Interference patterns were observed just as when the light is produced by many atoms radiating at the same time, showing that a single light quantum follows the classical laws of division at a half silvered mirror and of subsequent recombination with the phase difference required by the wave theory of light.

The structure of atoms as a periodic function and its relation to ion-formation and valence: ARTHUR A. NOYES.

X-ray methods and results in the examination of fibrous materials, particularly asbestos: GEORGE L. CLARK. (1) Typical X-ray diffraction patterns are presented for the following fiber-crystalline materials: natural cellulose, regenerated cellulose (rayon), silk, cobwebs, wood, stretched rubber, balata and gutta-percha, γ-polyoxymethylene (methyl ether), worked grease, drawn and rolled metals, and 7 varieties of asbestos. (2) A new modification of the monochromatic pinhole diffraction method is exemplified for the case of chrysotile asbestos. (3) The method of calculating the identity period in the direction to the fiber axis is shown to be entirely independent of any assumptions concerning crystallographic system or arrangement of atoms and molecules in the unit crystal cell. (4) The practical significance of fibering in terms of behavior is indicated, with particular reference to the use of the X-ray method in testing, specification and research. The patterns for the varieties of asbestos are correlated with action of acids, heat and most desirable properties when used as catalyst base (contact sulfuric acid process), Gooch filter, brake bands, etc.

Surfaces: W. D. HARKINS.

The photochemical decomposition of hydrogen-iodide; the mode of optical dissociation: BERNARD LEWIS (introduced by W. A. Noyes). The photochemical decomposition of hydrogen-iodide was studied at low gas pressures where the collision frequency is comparable with the mean life of the excited state. The quantum efficiency of the process was found to be about *two*, which agrees with Warburg's value for high gas pressures. This indicates that hydrogen-iodide dissociates in an elementary act as a result of absorption of radiation without the necessity of a collision. From the continuous absorption spectrum it is shown that dissociation takes place into a normal hydrogen atom and an excited iodine atom in the $2p_1$ state, the excess energy, if any, being dissipated as kinetic energy. It is pointed out that the time between absorption and dissociation is shorter than 2×10^{-8} second.

The volcano problem: ARTHUR L. DAY, of the Geophysical Laboratory, Carnegie Institution, Washington.

(To be continued)